

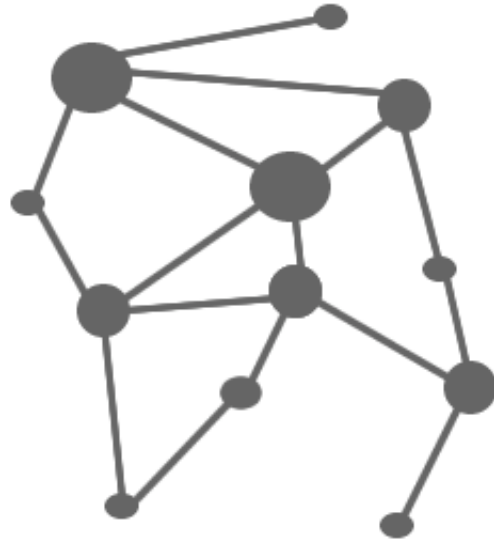
# Net Work

complex networks do real work within universities

Draft v 3.0

January 17, 2005

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status: draft, rough draft, outline

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## Preface

This book is meant to provide an additional point of view for understanding how universities work. Looking at universities and colleges as networks provides just one view that must be layered and combined with your other intellectual tools. My goal in writing this book is to provide a coherent treatment of how to construct a network view. I am not claiming that universities and colleges can be explained with just this one approach.

Of course I have written this book based on my own limited experiences and a necessarily finite selection of the literature. Although that is a limitation, it is also an example of the value of weak ties to other domains. This novel point of view is an example of the strength of weak ties. As the reader, I hope you will be able to take the ideas that I am presenting (that you might think comes in from the fringes) and combine them in your own way with your central experiences.

I am assuming that all of the readers have some personal experience with faculty-to-faculty networks that are responsible for the curriculum and research in these institutions. These networks will be studied as complex systems. In order to understand complex systems, you need to rely on a combination of metaphors, personal experience and simulations of possible outcomes. This book presents a set of network metaphors for university systems and example simulations that show the effects of changes in major parameters. You need to combine these metaphors and simulations with your own experiences.

My goal in writing this book is, of course, to further my own agenda. My agenda is to provide context for and a definition of **the intrinsic values of faculty activities**. University and college faculty are continually under attack and we don't have the language or models to defend our value. Individual faculty are judged by the reduction of their multifaceted, prismatic work to a single dimension of "productivity". Our society is just now realizing that there are important ecosystem services that we might not valuing properly. Similarly, I think we will start to understand that the network of faculty and staff in universities provide much more than just what can be counted (using production of student credit hours and publications), we will see that the value of our faculty and the networks they create do real work that is essential for the health of our institutions.



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## Chapter 1: Introduction

We've all heard the management gurus and business leaders telling academics to change our business practices to be more like them, i.e. to be more efficient and look at the bottom line. Maybe you are as confused as I am about this advice because when I look around, every major successful corporation in my area has built themselves a "campus". The companies that are the most profitable and cutting edge have emulated one of academia's costliest and most conservative attributes; colocated buildings with attractive surroundings. They have athletic facilities, lakes, walking paths, and cafes. It would be so confusing or surprising if you looked at the multiple integrated networks that are required for a large company to be healthy and to be ready for a wide range of future disturbances. If you're like me, you bump into your colleagues and students when I walk around campus. We exchange little bits of information. Colleagues want to know if I know what is on the agenda in faculty senate, and why that item is on the agenda. Students want me to know that they are worried about the assignment or upset at financial aid. All of these exchanges happen in a social context that can lead to a memo or an appointment, but they can also be an exchange, nothing more than a short bit of valuable information.

Universities are beautiful places. Sometimes, the beauty extends to the physical attributes. The buildings and grounds are inspiring expressions of the scholarly processes they house. But even in the plain buildings of a campus surrounded by a run-down neighborhood, the complex organization of the faculty, staff and students is a beautiful construction. In her book "On Beauty and Being Just", Elaine Scarry describes beauty as "Beauty brings

copies of itself into being." The network of faculty both begs for mimicry and has mechanisms for replication.

This book explores some aspects of the networks of university and college people that have been overlooked or, at least undervalued and under-accounted. In the view presented here, the inner workings of this network are crucial to the proper functioning on the university. In particular, I will propose that a network index called the "ascendency" should be a very good measure of how healthy these networks are. Ascendency includes both the amount of flow of work that is passed from one person to another and the specificity of each flow. For example, a colleague who provides work products to another colleague just at the right time and with just the right amount of detail for it to be most useful contributes to the ascendency. An administrator that sends out a memo to everyone in the university that requires them to read and respond, is the opposite of ascendency, it's pollution.

Recently, there have been many people who have been willing to share their organizational expertise with universities. Many of these people have had good ideas that are worth considering, but many others expect that universities will restructure themselves into the managerial flavor of the month. When we don't, we are seen as conservative bastions of outdated traditions. These gurus of the new economy have mostly been wrong. Wrong about how easy business is, very wrong about how to construct "pure play dot coms" and extremely wrong about universities. They don't understand how we work. What most of them came to realize too late for their own businesses is that there is real work that has to get done. A large part of the work gets done by people in the organization cooperating with each other.

I have no objection to people making suggestions for improvement in universities and it is a good idea for universities to try some of these out.

New ideas are always well received in universities. We take them, play with them, bat them around for awhile and then spit something back out. The little disturbances that these ideas make in our network fabric are beneficial. The response to each little stress actually makes us stronger. This response in fact, is my definition of a healthy network. The response I'm referring to is internal, and probably invisible to outsiders, especially unsophisticated outsiders who have a simple solution for everything. The flows in a network are dynamic, always changing to meet the demands. What is important for us to understand is that a healthy network can respond very well to certain types of stresses but can be disrupted by changes made at another level. For example, if a new employee is going to start work on Thursday, other employees are going to have to share their work with that new person and they are going to have to have a good idea of what that new person will need and what he or she can do. The ability of groups of people to adapt to changes is a function of the network that they have built. By the end of that Thursday, the network will have included the new person, be different and in a healthy network, actually be stronger and more resilient because of the process.

Mature complex networks that were self-formed and have achieved effective operation will respond to changes in demand for work through both sharing the load and sharing the benefits. When the locus of responsibility is, or is felt to be, at the level of individuals and small groups, people in the network will cooperate to get the work done. The selection process for improved network structure and flow is mutualistic. It is this mutualism that is so beautiful. It begs to be replicated in other aspects of the network. Even in an exterior environment of crass competition, the elegance of the internal organization will persist.

Unfortunately however, these same networks that are very robust to

demands made at the level of work, are very sensitive to some types of outside manipulation. For example, universities can try to enhance scholarship by providing stipends for individual faculty projects or by providing support for groups. My university has a very successful program that supports the formation of small groups of faculty to review each others writing. Depending on the focus of the participant's projects, the groups also have access to a faculty with expertise in statistics, research methodology or some other useful background. Using funds to support these groups avoids the trap of arbitrarily reinforcing one type of internal work product through incentives which can have a devastating effect on the self-grown mutualistic relationships. Meddling in scholarship by providing incentives for one type of work is related to the problem of mismatched logical types (Bateson pg 186). The mismatch occurs when external commands based on general information control processes that really should be left to internal control based on highly specific local information. The important message that I want to present here is that mutualism is a very powerful force in self-formed and self-regulating networks, but that undue tinkering with the structure of the network can disrupt this force. It seems that Anna Karenina effect applies: tragedy results not because there aren't many ways to lead a good life but because there many more ways mess it up. Similarly, there may be many ways a good faculty network can form itself; but there are even more ways for administrators to interfere. We need to understand what we should and shouldn't attempt to change.

The main theme of this book is that complex organizations of people do very important work that does not necessarily show up as export products from the system. We could compare universities to complex natural systems such as farms and wetlands. Farms are very valuable to society for what they export. Farms are highly managed and require subsidies of energy and nutrients to continue to export food for market. Wetlands provide very

valuable services for society such as cleaning water, air composition and as refuges for wildlife. Wetlands don't export anything that is normally traded in financial markets (although this is changing). Wetlands are not managed or provided with subsidies. There are some parts of some universities that might look like farms, but I am arguing that most universities are like swamps. A lot of activities take place in the swamp but very little of value is exported. I expect that many administrators will agree with the "swamp" metaphor, at least I hope they do. If you want to see the beauty and regenerative processes of nature taking place, I suggest you go to the nearest wetland. You will observe that the required power to control the systems comes from the internal processes.

The focus of this book is on the network of faculty, staff and students at colleges and regional universities. These institutions host highly valuable internal networks that handle the jobs of governance, improving teaching quality and faculty/staff professional development. However, the value of that network and the network processes are invisible or presently undervalued. This is because these institutions are trying to manage scholarly productivity with methods that are derivatives of the processes that worked in research universities. Many faculty and administrators at regional universities and colleges feel comfortable with the research institution approach because they were trained at these institutions.

*\*\*insert statement about different goals for research vs. regional universities\*\**

\*

\*

However, by the definition of "top tier", there are many more colleges and

regional universities than there are top tier research universities, finding appropriate ways to value faculty work is a wide spread problem for these universities that need to be addressed.

I will build my argument from the more obvious characteristics and benefits of a network, such as spreading innovations, to the more controversial argument for the retention of tenure. This argument has three major sections.

The first section (chapters 2 and 3) describes faculty organizations as networks and explains how these have value. Chapter 2 presents the network language that I will be using in throughout the text. Chapter 3 presents the spread of teaching innovations as an easy case for the value of maintaining complex internal networks.

The second section (chapters 4, 5 and 6) addresses the importance of individuals in networks. Chapter 4 demonstrates that more work needs to be done in nurturing individual actions in small groups, as subsets of the overall network. Chapter 5 presents a method for evaluating the importance and contributions of individuals in a network. This chapter directly challenges the assumption that measuring export characteristics will lead to an effective organization. Chapter 6 provides a critique of new products of scholarship that might be useful indicators for managing faculty creativity and productivity.

The third section (chapters 7, 8, and 9) takes on three crucial questions that are facing universities today; financial viability, sustainability and tenure. Chapter 7 presents a case for slight modifications of faculty/student interactions that could help faculty take responsibility for fiscal responsibility. The argument is simply that if we are going to balance the university budget with monetary and other added value, we need to make sure that our accounting of added value includes indicators of what we do

well. We need to add the value the services of the network to the university budget. Chapter 8 addresses how faculty and staff will contribute to sustainable universities by continually being in a creative cycle and by operating over a range of time scales. This chapter takes exception to the notion that a sustainable university can be growing in size. Finally, chapter 9 demonstrates how long term staff and tenured faculty are crucial to the operation of our institutions. In particular tenure should be preserved and strengthened because it forms a crucial barrier that blocks current trends from simply spilling over into the future and tenure provides a long term mechanism for the success of universities in the future. The very "conservativism" that we are accused of is shown to be a crucial part of the creative process.

Chapter 10 presents principles for managing a complex network. A manager maybe anyone (faculty or administrator) who is trying use some leverage to create conditions that will improve our universities and colleges. The criteria for what constitutes improvement is different in regional institutions and small colleges from those that would be used in traditional research institutions. The two principles for managing the health of complex systems: First, you can only apply a limited amount of external force or you will change the system you are trying to manage to another, different system. Second, you can only

\*\* insert statement about "purpose" of the individuals

\*

\*

The purpose of this book is to make an argument that is just coherent enough for the reader to follow the thread and just rough enough to provide

some edges for the reader to chew on, swallow and metabolize. It is not my intent to create a self-consistent all-encompassing description of complex networks of university people. The purpose is to help us see the beauty of the inner workings of universities, and in seeing these parts in a new context, learn to value them.



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## Chapter 2: Description of networks and their general characteristics

I have a friend in another department across campus who I met just by chance on our campus common area. I'm sure you have friends like this. They are outside your normal circle of professional colleagues. Except for chance committee assignments or conversations you might never have made a connection to this person. None of your colleagues know them or even know any of the colleague's colleagues. I found talking to this new colleague so valuable, not because she could comment directly on any of the work that I was doing, but because she had a totally different way of looking at almost every situation.

I realize that making connections within your discipline is essential to professional scholarship, but making these out-connections is valuable in a very different, almost intangible way.

\*more here

\*

### Introduction

This chapter presents the language for describing networks of faculty and academic professionals. The language includes ways of describing the structure and the behavior of these networks. I have adapted the approach taken by biological ecology to study networks. In some ways networks in universities are

simpler than biological ecology because our academic networks only contain one species. But because these networks are made up of humans they are very complex. I have not yet been able to find any description of human behavior that is acceptable to any broader audience than its (the descriptor's) parent discipline. When we compare human social networks and biological ecology networks, they are both complex systems. In this book, I am mainly interested in the cases in which the complexity of the two systems will be similar enough that we can use this approach.

The chapter provides an introduction to concepts that will be developed in more detail later. It starts by describing the network structure and patterns in the processes. Second, it addresses external regulation and internal self-organization processes. Third, the process for scanning the major features of an academic network is described. This scan includes looking at the context of the network, the physical organization of the people, the discipline structure, and the internal peer-to-peer connections. Finally, there is a glossary of terms that are defined and compared. This might be particularly useful because networks have been studied in many different disciplines, each with their own specialized vocabulary.

## **Description of network structure and behavior**

The focus in this book is on flexible networks of association between faculty and staff. Some of the network linkages may be formal, establishing lines of authority or responsibility. Most of the links in an academic network are informal, passing queries or information, exchanging tasks or cooperation. The connectivity of this network is the number of linkages that are formed, but that number may vary with time. In a time invariant network, the connectivity is the number of linkages that are formed and the "ascendency index" is a measure of the amount and

specificity of the information flow. A full explanation on how to calculate the ascendancy index is given in Appendix 1. For now it is sufficient to know that the ascendancy index increases with both the total flow and the specificity of the flow between nodes. The specificity can be interpreted as the information that the network contains to direct the flow of information to just the right node in the network.

Characteristics of network response to stresses are also of interest. For example, if a network of faculty is stressed by the appearance of a new innovation within the network, faculty may respond by imitation and propagation of that innovation through the network. Similarly, if there is work that has to be done by a group of faculty but one or more members are unable to contribute, the other faculty will adjust their workload to cover the task. These seemingly small scale perturbations are communicated through the network and individuals make appropriate responses. The concepts of stability, resilience and resistance are related to how well the network responds to such perturbation stress. Stability is how close the system stays to its initial state. Resilience is the amount of stress that the system can withstand before it changes to a different state. Resistance is the response of the network to counter any change imposed on the system.

Previous work on social networks and more recent work on biological networks has demonstrated the importance of weak links in the network performance. Granovetter's original paper in \*\* 1978\*\* and a follow up paper in 1982 describe how weak ties across social units provide benefits to the entire network. In particular, when innovation is constrained by the current perspectives of a discipline, weak ties to other disciplines or even to the edges of one's own discipline can provide extremely valuable perspective the network as a whole.

Control of the function of a network is related to the structure of the network. Ashby's Law (\*\*\*\*) states that appropriate regulation needs to be of the same level of complexity as the system being regulated. Functionally this means that

complex systems are needed to regulate complex networks. The most obvious locus of control for a network is within the network itself. The mechanisms for embedded network control and internal regulation are discussed again later in Chapter 9, "The beauty of tenure", and in Chapter 10 "Using ecological principles to manage networks".

### **Internal self-organization and external control**

There are two levels for controlling a network, external and internal. The mechanisms and structures for these two levels of control are very different. External control is often embedded in the administrative hierarchy. The external control structures are clearly described as a chain of financial responsibility. Even though they are clearly described down to the department and faculty levels, the internal controls may actually be dominant at these other levels. Tenure, formal academic departments, and informal communities of practice are all operating to make the workings of the internal faculty much more sensitive to the faculty network than to specific external constraints imposed by the hierarchy.

Self-organization processes within the faculty network may lead to a critical state. As a network of faculty grows or reforms (from continual minor perturbations) new connections are made from one faculty to another based on which connection is perceived to be the most valuable. This process of preferential attachment (Barabasi 2002) will build a network structure that consists of valuable hubs with multiple connections. In actual practice, many of these networks build out as scale-free distribution of connections with major hubs connected to common hubs and finally individual connections. The result of this process can be the construction of a network with connections that have a

fractal characteristic, a point on each level has the same ration of connections to a higher level as it has connections from a lower level. The process of network formation is important in regulation. The complex networks we are studying can be considered to be "cognitive networks" in that they brings forward new versions of themselves (Maturana and Variela \*\*\*\*). Thus, the growth and reformation process is also part of the regulation process.

*\*\*expand this last section \*\**

*\*\* put in synopsis of Arrow et al \*\**

## **Scanning the major features of an academic network**

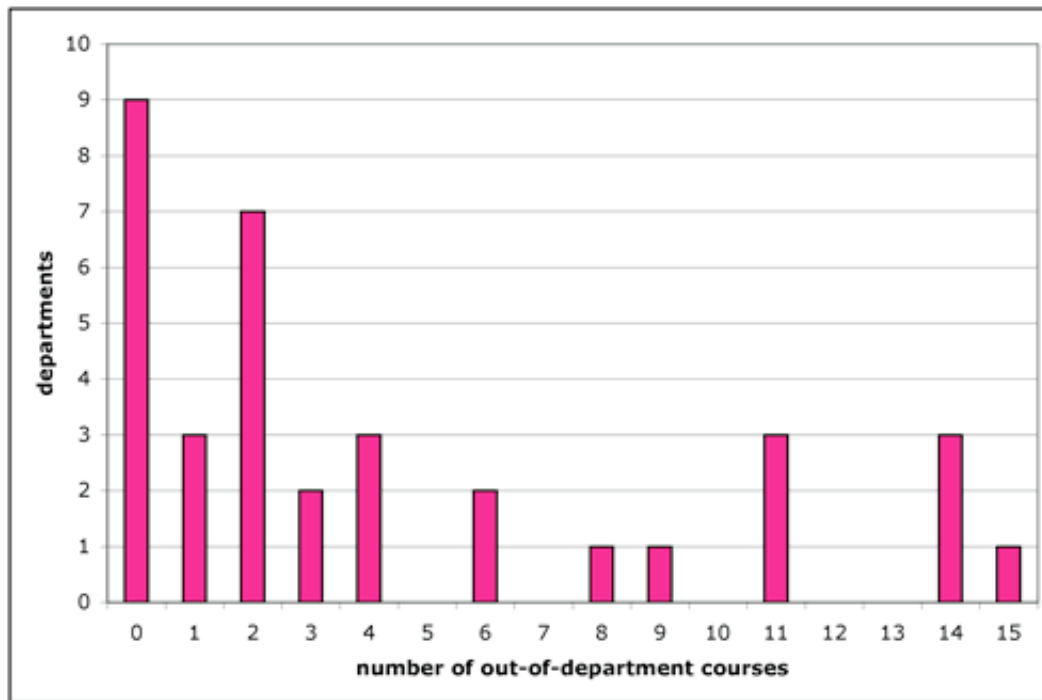
The following section provides a short description of how to scan and describe the major characteristics of a complex faculty network. For the purposes here, I will limit the discussion to practical measures that can be applied to academic networks and will help in understanding the value of individual action and susceptibility to external forces. Furthermore the characteristics should have implications for the spread of innovations, handling internal stresses and how the entire system should be managed. The scan for the major features includes two attributes of the structure, physical and architectural structure, and the structure of discipline and curriculum connections. The scan also includes a look at the functional aspects of the peer-to-peer information sharing network.

physical structure - The architecture of offices, meeting areas and buildings have substantial impact on intellectual networks. In businesses, physical proximity was related to the number of communication, with the likelihood of interactions being four times higher with a colleague whose desk was six feet away as someone whose desk was sixty feet away (Gladwell 2000, discussing the work of Allen). In a university with multiple buildings or even multiple campuses, interaction between people can be extremely limited just based on their relative physical locations. A physical scan of the university network should look the density of faculty offices and the location of attractions, such as coffee stands etc. *\*\* insert anecdote about limited activities and almost agoraphobic behavior\*\** One of my colleagues has a set path from her office to the coffee bar which she calls her "habitrail".

There are also barriers to interaction that should be considered such as the amount of bad weather, busy streets, slow elevators, safety hazards or general ugliness of a particular area. From personal experience however I know that arbitrary physical proximity doesn't necessarily engender faculty to faculty interactions. The physical characteristics of faculty interaction are crucial for cross-disciplinary studies. The physical organization of faculty offices needs to be taken more seriously.

discipline structure - In my experience, undergraduate degree programs are more unrelated than related. In a recent review of the programs at my own institution I cataloged the number of courses that majors were required to take out of their department (Figure 2-1). This table shows that the departmental requirements for most degrees do not make many formal connections to other disciplines. The departments probably expected students to get those connections or breadth from general education requirements.

Figure 2-1. Number of departments that require a certain number of out-of-department courses. The data was collected from the departmental degree descriptions and does not include any general education or university requirements.



The library is a frozen physical representation of arbitrary discipline boundaries. *\*\* insert endless shelves, little aisle, Borge\*\** In my view, the library should be one huge floor with a mezzanine for study areas that would look over the entire floor. Library patrons could see the movement in all the stacks. In addition library operations are fighting a basic process in self-organization, stigmergy, which is the communication through artifacts. Books that are in high demand and in use, are missing from the shelves rather than being there. Stacking shelves should be at the end of each row of stacks such that the books that are in constant turnover would be displayed. At a glance I could tell what my colleagues and students were reading. In our library, which is an excellently run facility, the sorting stacks aren't even on the same floor as where the books are shelved.

peer-to-peer - Characterizing the actual network interactions within a medium sized university would be a much larger undertaking than any of the previous network studies. \*\*ref on the medical and farm studies that had only hundreds of participants and only along a few dimensions \*\*.

description of the strategy -

sampling strategy, the network is probably larger than funded studies

Valente table of size

who knows each other (phone book survey)

who passes information (interviews)

sampling matrix - need representatives from all categories

looking for characteristics - see chapter

renormalization of the network (chunks should percolate)

\*\* network structure analysis \*\*

## **Conclusions**

Networks of faculty can be described both structurally and functionally.

Universities and colleges are complex networks in which the flow of information

and services are on several planes simultaneously.

The internal regulation and external controls should be related to the structure of the real network, not just the espoused organization chart.

Understanding the structure of university networks can start with a scan of the four main determinants, physical layout, discipline organization, committee structure, and flexible peer-to-peer connectivity.

"Ascendency" is of the key ideas in network value. This concept will be discussed more fully in subsequent chapters.

## **Glossary \*\* needs to be filled in\*\***

Below is a list of terms and how they are used in this book.

ascendency	
Ashby's Law	Any solution should have the same level of complexity as the problem itself.
average mutual information	
centrality	
cognition	
competition	
complex	
connectivity	
development	quality, specificity, vs. growth
disturbance	
dynamic system	
entropy	
group	compared to network
growth	

hierarchy	
internal rules	
level of complexity	algorithmic length
management	
management strategy	
mutualistic	
network	
network structure	
power	physical science definition, academic hierarchy definition (see Birnbaum also)
regulation	internal control
renormalization	
resilience	not the same as stability
scale	
self-organizing	
self-regulating	
system	boundaries
work flow	

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## Chapter 3: Spread of innovation through networks

*\*\* lead in story \*\**

### Introduction

I will use the definition that an "innovation" is an intellectual product that provides a product or process that somebody else can use. The better the

innovation, the more it will be used and the more it will spread. As Metcalfe (1999) said, "Invention's a flower, innovation is a weed." This chapter explores the parameters of the social networks at universities that promote the spread of innovations. These parameters are: the structure and connectedness, strong and weak ties, spatial organization, degrees of change in the environment, and quality of the information that is being transmitted. I will examine several specialized situations for academic environments.

New ideas are key, not only to universities but to our modern economy. These ideas spread through social networks. Malcolm Gladwell (2000) claims that "innovation--the heart of the knowledge economy--is fundamentally social." The spread of ideas happens through the innovation commons, which is a hybrid of intellectual property and public good (Rheingold 2002, pg 47 \*\*is he quoting Lessig\*\*), and as a commons requires social governance processes just like other common pool resources (Ostrom 1990). No matter what technology is employed or how valuable the idea, you don't just "run it up the flagpole and see who salutes", it takes social connections based on trust and reciprocity for meaningful change.

Innovative ideas have value to the individuals in the faculty. Faculty form connections that help them learn and imitate each other. These individual connections will self-organize into a network structure that spreads innovations widely and effectively. Another important observation in this chapter is that the same characteristics of those networks that promote the spread of innovations also promote a healthy response to stress. Thus if conditions are created that nurture a healthy network of faculty, that network will do the work to both help advance intellectual assets and manage stress.

## **Value of innovation**

The general pattern of the spread of innovations is important to the institution. The pattern occurs because individuals can gain from either innovating or imitating a successful innovation. The work of Boyd and Richerson (2001) puts this choice in the context of bounded rationality. People have the choice to combine information that is available to make a new behavior (innovate) or, if this is not sufficiently better they can imitate a previously successful behavior. Innovation is risky because it hasn't been shown to be successful. However if there is no innovation in the population, they will not be able to deal with novel situations. Boyd's and Richerson's model describes an equilibrium condition in which the probability that individuals imitate depends on the quality of the information and the probability of environmental change. The quality of the information is modeled as the standard deviation of the data around an environmental cue. As environmental change increases, the amount of innovation increases. In their words, the **check this quote** "payoff of **to?** learning individuals increases as the amount of imitation increases because individuals are demanding better evidence before relying on their individual experience and therefore are making fewer errors." However if imitation is too common, the payoff for imitation declines because the population doesn't innovate enough to deal with changing environments.

## **Metaphors for the spread of innovation**

Although early articles referred to the "diffusion" of innovations more appropriate metaphors would be the percolation of innovation or contagiousness of innovation through a social network. Diffusion implies a high concentration source at one end that will eventually spread out to a

lower average concentration. There are two problems with this metaphor. The first is that innovations aren't "pushed" from one spot to another because the local source of innovation has higher concentration and energy. In fact, the source of some innovations could be small and minimal. The second weakness of the diffusion metaphor is that the net transfer isn't caused by some random movement of ideas (Brownian movement of diffusion) but instead depends on pre-existing social connection between the innovator and the receiver. Another problem with the diffusion metaphor is that it gives the impression the background media is inert and uninvolved, when in fact innovations spread through dynamic social networks that change the innovation and are changed by the innovation.

Metaphors in which the matrix of the network is more variable, dynamic and involved are preferable starting points. Innovation has been compared to the spread of disease, forest fires and even percolation through heterogeneous porous media. Each of these metaphors has limitations and dangers, but they serve as useful heuristic devices for studying innovation. For example, describing innovation as a contagious process may help focus the study on the susceptibility of the receiver and the recovery time between being hit with one innovation and the next. Using a forest fire metaphor might help illustrate the connectivity of the pre-existing network and whether it was under- or over-connected or whether there were pockets of the network that were protected from the current sweeping innovation. Percolation models are initially less intuitive (unless you're a soil engineer) but there are tools that can be employed to analyze percolation if the problem can be mapped as a percolation problem (Stauffer and Aharony 1992). Multiple metaphors should be considered and compared in the study of any complex system.

Because the spread of innovations is so complex, good metaphors are also

very valuable for communicating the central points. This can be seen in the original diffusion metaphor, it gives the impression that innovations will occur and spread, that it is a natural law of mass action. This metaphor fit well with the industrial world view, i.e. that progress can't be denied and that improvements to society from global industrialization is destiny. The industrial mind set has been evident in academia. The journal for the American Association of Higher Education is called "Change". I have heard one university president claim not only that we needed change, but an accelerating rate of change. My colleagues and I dutifully resumed our roles as frictionless pucks in the lab of an ambitious administrator and assumed that she was hoping for the second derivative of intellectual achievement to be positive. My sarcastic point is that we are not just interested in change, but how and where it takes place and its direction. We need to employ our metaphors carefully and not fall into traps that oversimplify the description of change. Bateson (2002, page 58) reminds us that all statements about change need to be precise about the logical type. Many familiar statements such as "the more things change, the more they stay the same", are useless "wiseacre wisdom" because they muddle logical types. We need to be careful in both selecting our metaphors and making extensible claims that we don't fall into the same trap of over simplicity.

It is probably an appropriate time to consider multiple metaphors for the spread of innovations through complex social networks. Each metaphor can contribute to our understanding. It may not be possible to get the views from different perspectives to converge into one self-consistent and coherent image. This lack of coherence can be explained in two ways. First we might believe in postmodernism, as Harvey (1990) states "The simple postmodernist answer is that since coherent representation and action are either repressive or illusionary." Or second, we might be more pragmatically interested in just using these views as heuristic devices to help start our

inquiry into these complex systems. Either way, philosophically or pragmatically, an expanded repertoire of metaphors for networks and innovations will be valuable.

## **Parameters that control the spread of innovation**

Previous studies of innovations in a variety of contexts have identified parameters that may be useful in academic environments. The studies have been on disparate systems, from farmers in Sweden to doctors in the U.S., but they illustrate several things that should be considered when describing a the spread of innovations. The parameters that describe the overall structure of the network, such as connectivity and centrality, have been described in more detail in Chapter 2. Here I will focus on four conditions that are more directly related to innovation than on the structure of the network. These conditions are: 1) the value of the information available to participants, 2) the number of weak versus strong ties in the social network, 3) the spatial and architectural context of the participants, and 4) mechanisms for developing reputation and trust.

1) The value of information available to participants was discussed above. The driving forces relate to the value of the information in relationship to the predictability of the environment. In an environment where any individual cue is a poor predictor of change, it is better for individuals to avoid the risk of innovation. The population will imitate when information is bad and learn, or innovate, when the information is good (Boyd and Richerson, 2001). However, some amount of risk and uncertainty is important because individuals are more likely to look to other people to gain more information and for reassurance about potential decisions on the adoption of particular innovations (Valente, 1995). Just as a intermediate

level of connectivity leads to complex networks (see Chapter 2), an intermediate level of information reliability helps promote healthy networks by building resilience (Gunderson and Hollings \*\*\*\*).

2) Innovations spread in the context of a social network. Although some academic networks are almost purely formed with intellectual connections (such as the clustering of mathematicians (Barabasi 2002)). University networks are highly social. These networks exist to serve a wealth of purposes for the participating individuals and thus have many qualitatively different links. There are strong links between members of a group within the overall network. These people are likely to be culturally similar and have access to the same sources of information. In a large network there are also numerous weak ties that can provide crucial conduits for the flow of information to individuals (Granovetter 1982). These weak ties are valuable to the network and individuals exactly because they link parts of the network that may have different information at different times. If the links were too strong, the network would be homogeneous. There are institutional mechanisms that explicitly promote weak ties, such as cross-disciplinary or cross-college committee assignments. There are also weak ties that may be just as important, such as affiliations in extramural social organizations or living in the same neighborhood. From my experience, the total sum of back channel reciprocity is one of the driving forces in university life.

3) Spatial organization and proximity are crucial in the spread of innovations. In the classical study by Hagerstrand (1967) on the spread of different types of innovation in Swedish farming practice, the dominant parameter was proximity, the farther someone was away from the center of a new practice the less likely they were to accept and adopt the innovation. Part of this could be explained by the fact that the spread of new farm

practices depends on physical conditions. However, Gladwell (2000) describes the spread of innovation in modern offices and refers to studies that show that simple communication between individuals drops off dramatically as the distance between their desks. People who have desks more than sixty feet away from each other rarely communicate. In addition there have been studies on the architectural features that promote communication. Elevators, coffee kiosks and pleasant alcoves can lead to much higher social interaction (Lieberman \*\*\*\*). These examples suggest that the distances and architecture of our working environment could play crucial roles in the flow of innovations.

4) Trust between individuals is crucial for the integrity of any social network. Reputation building mechanisms are important, not just within the research disciplinary but in all aspects of academic life. Unfortunately, I have seen many cases when a healthy academic skepticism slid quickly into a lack of personal trust. At one level this makes sense to me, our academic disciplines are powerful agents for creating a sub-culture and molding the world views of the doctoral students who later populate our institutions. For example, it can start with an uneducated distrust of the qualitative, lead to an unsophisticated disdain for qualitative approaches and eventually to an ignorant and subconscious dismissal of entire disciplines. We need to avoid using phony animosity as an excuse for not engaging with people from other disciplines. A lack of shared trust will interfere with the operation of an "innovation commons" (Rheingold 2002). Fortunately, universities and colleges have an embedded, appropriately complex and highly sophisticated mechanism for developing the reputation of faculty through the tenure process which will be discussed in more detail in Chapter 9.

## Examples of specialized academic situations

I have studied several aspects of the spread of technological innovations in teaching and learning. The details of these studies illustrate the obstinacy of actual networks.

Support for innovation with backsliding - A common assumption in the studies on the diffusion of technological innovations was that once a person adopted the innovation they wouldn't revert or backslide. This is a central assumption in the work of Valente (1995) which focused on network models of the diffusion of innovations. We used the categories from (Rogers \*\*\*\*) of innovators, early adopters, early mainstream, late mainstream and laggards, but in our work (Rueter and Lieberman \*\*\*\*, Rueter and Perrin 2002), we added both the support requirements and retention characteristics that also characterized these categories of faculty. Support requirements ranged from none, for the innovators, to required continual access to support for the late mainstream technology people. Similarly, the retention of adopted teaching technology ranged from long term for the early adopters to what we called "brittle" for the late mainstream. We constructed a dynamic model of our population of faculty and the amount of effort that was required to recruit and sustain these people. During a time when it was a generally accepted goal that everybody in the university should be recruited to use educational technology, I used this model to illustrate how over-recruitment could lead to the counter-intuitive loss of the number of faculty using teaching and learning technologies. This could happen if so many people were recruited into the pool that the per capita support dropped below what was required for the large population of mainstream and late mainstream users to sustain their usage.

Table 3-1. Categories of faculty with respect to their attitude

toward innovation. Other characteristics of their requirement for support and susceptibility to backsliding. Taken from Rueter and Perrin \*\*\*\*.

<b>Category</b>	<b>Recruitment &amp; learning curve</b>	<b>Technology Support requirements</b>	<b>Retention</b>
innovator	no recruiting effort rapid learners	maybe low from faculty development	long term
early adopters	minor effort rapid learning	moderate and in spurts	will probably stick with it
early mainstream	substantial effort reasonable learning curve	higher and continuous	fickle: may drop out if technology is unreliable
late mainstream	major effort trainable but slow	highest level of continuous support needed	brittle: may drop out after minor failure of technology
laggards	uninterested	not feasible	

Innovations of dematerialized products - As we developed teaching innovations that utilized communication technologies (in particular the internet) it became obvious that some of these were very different products than had been previously studied in innovation research. In particular, some faculty were able to create products that simultaneously carried both the concepts for improved teaching and the tools to implement that approach. For example, I created a simple web page that describes and illustrates how

to calculate gene frequencies, but the same page that carries that information also used Javascript to calculate the frequencies for a student worksheet. That page, and many others created by my colleagues, contained both a new idea and the tool. We called this combination of message and tool "rich links". In the previous diffusion of innovation literature, most of the technology and concepts were separate, for example how to use an electronic typewriter and access to the typewriter *\*\*insert reference to Jane XXXX\*\**. This required separate channels for diffusion of the innovation (physical access and knowledge) to be available. The results from this insight lead us to promote bundles of pedagogical approaches and tools that could be widely adopted. One of the successful applications of this was to give students prior learning assessments on the web as a quiz that returned information directly to the faculty and students. Once we provided an easily modifiable cgi program for grading this type of quiz, many faculty employed pre-enrollment self-assessment quizzes (PESAQs) as part of their courses.

Disruptive innovations - Over the last years technological innovations have had a great impact on teaching and learning in higher education. Some of these innovations could be classified as "disruptive innovations" (Rueter *\*\*FOF article\*\**) Christensen and Overdorf (2000) describe a disruptive innovation may not be good for productivity right now, but the disruptive innovation could lead to higher productivity in the long run. I predicted that wireless communications and teaching with databases would be upcoming examples of disruptive innovations in higher education. As it turns out, I was wrong about wireless communications because it became so cheap that institutions just added wireless on top of wired technologies and there was no requirement that faculty redesign course material for wireless devices. *\*\*insert right about teaching with databases, time to implement, control to software like WebCT\*\**

Now, I would reinterpret the entire idea of disruptive innovations in the context of scale. Technology can be adopted, mature and reformed all simultaneously at different scales, with different loci across the university. Technology can be seen as going through the resiliency cycle described by Gunderson and Hollings (2002). This suggests that the management of innovation in teaching technology needs to pay attention to pockets of smaller scale and strive for an intermediate connectedness of the larger network. If I were still involved in faculty development with technology, I'd try to focus at small groups and not worry about everybody in the institution getting the same amount of information about new ideas. In fact I'd resist making everything "ubiquitous" and "seamless" and try to leave room for more texture and heterogeneity.

### **Healthy networks spread innovations and eusocial norms**

Ulanowicz (\*\* in Costanza \*\*\*\*) defines a healthy network as one that responds to stresses with changes in the current network that improve the performance of the network. This means that the network will perform better, be more resilient, in the changing environment for which additional stresses will continue. The resilience that develops in these networks comes from rearranging internal connections in response to the disturbances. Innovation is a stress for networks and, as we saw above, can cause disruptions across different scales. As networks respond to innovative stresses, they become healthier. Thus innovation results in value to the individual, to the institution and to the structure of the network.

Flow of innovations through an academic networks happen by imitation and adaptation. Imitation is more than just a form of flattery, it is essential

process in holding complex societies together. Toynbee (\*\*\*\*) talks about the "dominant minority" as the cultural elite that holds the society together through their creativity, which others mimic. The process of mimicry and adaptation forms a connection to the values that underlie the dominant minority's creativity. In a university, the most visible minority are the tenured faculty who are rewarded for their productivity and service. Often the biggest rewards, and thus the most visibility, goes to the people who have had the most success in servicing the university's overhead function by bringing in money (import) and publishing papers (export). Some other people have contributed their creativity to the less tangible areas of helping organizing the internal complexity into a more mutualistic manner, i.e. created ascendancy in the complex network.

The academic innovation commons, presents a collective action dilemma to its participants and supporters. There is a rational conflict between doing the work and taking the risk to provide new intellectual property for the commons, and using the existing information put their by others. Our universities and colleges solve this problem by forming a sophisticated network of collaboration and mutualism. The conflict is solved by communicating norms broadly across the network through weak ties that bridge across all areas of the network. Boyd and Richerson (2001, page 283) state that "Virtually all of the recent literature on norms focuses on how norms help people solve public goods and coordination problems". Wright (quoted in Rheingold 2002, pg 212) claims that human societies are moving toward social systems that amplify cooperation and that humans have learned to "play progressively more complex non-zero sum games with the help of technologies". These solutions are sophisticated and involve the latest technology (from the printing press to wireless networks). It is important to remember that what the network is passing in these cases is not just the innovations, but the cultural norms. Norms can not be created by

planning and are not the sum of sets of institutional objectives. Norms are value laden descriptions of how people should act. Innovations, spreading through a network, have the power to effect real cultural changes.



# Net Work:

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## Chapter 4: Importance of the scale of interactions

*\*\*see my notes on linking scales\*\**

There are many layers and scales of faculty work in universities and colleges. In many cases, the problem isn't that we aren't working hard enough, it's that we are distributing our creative efforts at the wrong scale. It seems as if we are always asking ourselves questions such as "Am I expected to do this task for the university?" or "Isn't that supposed to be done by committee A?" Or, worst of all, "I thought I was supposed to do that, but I guess they didn't need my effort". If you're like me, these questions both nag at you and undermine your enthusiasm for working at the larger university scale.

### Introduction

The purpose of this chapter is to explore how we, as individuals, fit into the different levels and types of groups at the university. I think that by understanding how these different levels work together and what is most

effectively done at one level rather than another, we can increase the value of the university. One outcome of this type of analysis is to demonstrate that there is some important work that is done by the entire network of individuals. As individuals, we need to act in ways that feed and promote that work. This point is the subject of previous sections. There are two points from this analysis that I will make here. First, small groups of friends or committed colleagues (3 to 7 people) are crucial to the actual operation but are under-appreciated in the hierarchical view of the university power structure. Probably the biggest improvement in the quality of our institution could be achieved by more attention to this small group level of interaction. The second point is that the hierarchical view of the university is very valuable for understanding the power relationships, but this view needs to be related to the actual network of the university, which determines the creative potential of the university. Power and creativity share the requirement for effort, but power makes resources available and creativity uses these resources. *\*\* Capra quote \*\** In my view, the creativity of the institution comes directly from a healthy network, and this is enabled, not created, by administrative action.

This chapter proposes that we can address the questions that nag at us individually in two ways. First, abstractly, we can try to understand how we can contribute to the total creative network of the university. Second, concretely, we can make a real contribution to the quality of the university by paying more attention to helping out our small groups of friends and colleagues. In the ecology of our institution, we need to "think globally, act locally".

## **Description of the levels of work at the university**

The tasks and ongoing work to keep our universities running need to be better

understood. Some of the work is done at each scale, from the individual faculty to the entire network of everyone at the institution. For the purpose of this paper, I am simplifying the description of the work to only five levels:

1. Contributions to the entire network. Some individual work that we perform can relate to anybody else's work at the university. This level of work is a very intricate web of interactions that we create and maintain through all of the work and contacts. Depending on your point of view and definition of what our university is, this network either is the university, or it performs work that is crucial for the university. My view is that this complex network **IS** the actual university. Our efforts as individual contribute to a healthy structure that performs many useful functions. This will be discussed in the next chapter.

2. The university also has a hierarchical structure of administration, schools and colleges, departments and programs, and individuals. From my viewpoint, the hierarchical structure is just one arbitrary projection of the real and complex network onto a single dimension of authority and financial responsibility. This projection is useful for clarifying the distribution of resources of the university and the power structure helps make some decisions both quickly and efficiently. The art of management is to choose projections, lines of responsibility, that help increase the productivity and creativity of the institution.

3. Our university contains a significant number of committees and organizations at a large scale. Some university committees have 15 to 20 members. The University Senate is probably the largest group and has about 100 members. These groups are probably too large for effective work, but they represent an extension of the

hierarchical power structure into the more complex network for the purposes of governance and administration. In the vocabulary of Arrow's book on complex small groups (Arrow et al. 2000), these are "concocted groups" that have been assembled by external authority and have planned goals.

4. Because of the external forces in the university, there are also many smaller groups that form on their own because either people are thrown together into the same situation or that self-organize due to internal or personal level forces. Arrow (et al 2000) call these groups "circumstantial" and "self-organized" groups, respectively. This level is probably the most influential and potentially the most efficient venue for faculty work, but also the most under-appreciated.

5. There are a number of crucial tasks that are done by individual faculty and staff working on their own for their own satisfaction and rewards. In a complex organization, not all of this work is directly related to the job description, requirements and rewards. Especially in universities, there are many examples of work that are intangible or invisible to the hierarchical projection. For example, the continual critical review of courses that happens each time they are taught is invisible to anyone except the instructor and the students in the course, yet this is one of the crucial processes that improves the quality of our curriculum. The revision of the reward structure to manage intangible assets was addressed in a previous paper (Rueter and Bauer, in press) and will be addressed in Chapter 6.

Of course any actual situation is not this simple. The arenas for action overlap and individuals make different types of contributions. For example, a

department that is "constructed" (Arrow et al \*\*\*\*) as part of the university hierarchy can actually emerge to function as a "circumstantial" small group on other tasks. My argument is that we need to pay more attention to all of the small groups in which we are involved and use this as a mechanism to maintain and build-out the full network. It is my contention that this healthy network that we build will be better at acquiring the resources than the hierarchical projection. I believe this based on recent observations on the prevalence of mutualism rather than competition to solve biological problems of resource variability and scarcity \*\*(reference \*\*). Managing the conditions for complex networks will be addressed explicitly in Chapter 10.

## **Small groups**

Kirkpatrick Sale (Sale 1980) is very fond of magic numbers about scale. His number of people that form an effective working group ranges from only 4 to 6 (\*\**check this*\*\*). As groups get bigger there is a diffusion of responsibility and other disconnects. Even assuming the best case with universal good will, motivated committee members and energetic people; a smaller group is just more effective than larger groups. Unfortunately, the political landscape seems to accept as a fact that we need to have all committees to include all stake-holders in order to see a diversity of views. Although the committee membership and activities meet pluralistic goals, these goals may interfere with the necessary work that the committee fails to complete.

Many of our small groups are dismissed because there are perceived to be more social than work related. We need to rethink our perception of this. A very important feature of many small, self-organized or circumstantial groups is that they are subsidized through the additional currency of reciprocity. Members perform services or provide information to each other in an informal

exchange. Often this currency goes beyond the academic environment; your friend helps you put up a web-page and you help them baby sit their cat. These small groups aren't based on accounting but these "back-channel" services provide real value to all of the members.

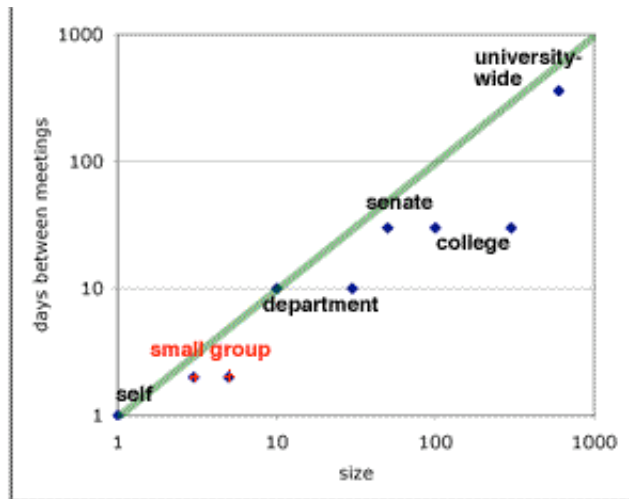
In my experience, these small groups last for a long time and include the entire range of people at the institution. There may be faculty, grad students, office staff, advisors, and non-university people in these groups. Thus, these small groups provide the very real, and needed, connections throughout the universities different structures and to the outside. For example, everyone doesn't need to have a close friend in the admissions office for effective feedback. It is usually sufficient for just one of your group to have a contact into that office to get effective intergroup information flow. In a network description, it is only required that local ideas are able to percolate out of the local scale in order for the entire network to see them.

In an institution that it is relatively isolated from the outside, such as a university, most of the work is self-referential, i.e. the work of individuals refers to the department and the department tasks are in the context of the college, etc. The sharing of ideas and dissemination of ideas takes place in this network context. Each idea has a specific source and target, and thus context. I will present a hypothetical view of these idea transfers that depend on the size of groups at the institution. The frequency of transmission of ideas is related to the frequency of group meetings. Below is a table and figure that show this relationship. Notice how the small group activities form a crucial link in the connection of the activities on the individual scale to the activities of departments and larger.

Table 1. Size and frequency of group meetings in the university setting.

Figure 1. Scale of group size and activities.

Group	size	time between meetings
individual	1	daily
<b>small group</b>	<b>3 to 5</b>	<b>2</b>
department	10 to 30	weekly to bi-weekly (ave = 10 days)
senate	50 to 100	each month
college	50 to 300	month
university	600	annual



The above discussion demonstrates a key feature of working with complex networks which is that we need to pay attention to the connectivity at smaller scales in order to provide a transition to effective network activity at larger scales. In practice, whether we are looking at managing lakes, forests or information systems, the critical focus should be on any gaps in the relationships between different scales. This key feature is fortunate for us, because it means that often an individual needs to spend more focus at just one step up in scale and this is just an extension of what individuals are doing on their own personal scale.

## Power versus Creativity

Fitjof Capra (2002) stated it eloquently and put the conflict in the context of

complex systems when he said, "In every human organization, there is a tension between designed structures, which embody relationships of power, and its emergent structures, which represent the organization's aliveness and creativity." This conflict is also represented in the range of descriptions of a university. For some people it seems that our university is an instance of a grand tradition of the "academy". In their view, we need to respect the traditions of academic freedom and social responsibility *\*\*insert more here, this is too simplistic\*\** that have been the hallmark of universities. Their ethics require that we honor these past efforts and sacrifices by maintaining the highest level of scholarship and productivity. At the other end of the spectrum, is the view that our institution is the people and rules that are in force at this moment. In this view, the institution has a primary responsibility to the current employees and students. There are areas in which both of these views would converge, however on the issues of the value of the institution they diverge; one focuses on export and the other focuses on internal connectivity.

University administration is usually associated with the top-down management of productivity and export. This naturally stems from their responsibility to the public to justify public and private support for the institution. In this sense, export productivity is tangible, measurable and contributes directly to the supporting community. Administrators usually look for models based on management ideas that use incentives and structural solutions. In contrast, the more idiosyncratic institutional view that values individuals and their connections is usually espoused by some faculty and staff. These people have personal experience with the work that they do and how it is necessary but often unrecognized as such. These people would really like to know that their individual small steps will aggregate into a greater benefit for the institution. Of course, neither view is "correct". *\*\* insert example .....* We need to maintain the tension that Capra spoke of to keep the institution away from

equilibrium, to keep the institution in a dynamic and energetic state. Many of the traditions that we have acquired from historical universities help maintain this energy and avoid the complacency and irrelevance of other public institutions.

Creativity and power come together in a dynamic context in the resiliency cycle of creative destruction as described by Gunderson and Hollings (2002) (see Chapter 8, Figure 1). *\*\* insert a figure of this relationship \*\** This cycle is based on ecosystem growth and disturbance cycles but it is applicable to allocation of university resources. The cycle "starts" with a rapid exploitation of available resources (r phase) followed by the system reaching carrying capacity in which all the resources are used very efficiently (K). As the system invests heavily on efficiency for a single resource, it becomes brittle and eventually collapses or is disturbed by outside forces. During this disturbance phase (omega) the resources are liberated back to the environment. In the presence of these newly available resources, the system innovates and creatively reconstructs a resource base (alpha phase). This alpha phase is the crucial phase in a sustainable cycle, the resources and the network interact to self-organize a new base. Many human systems, including management strategies, short change this cycle by either trying to force the system to stay at the maximum yield (the border of the r and K phases) or by exporting the resources that will be needed for the omega phase. Universities, by design, are great examples of how this cycle can be institutionalized. Individual faculty are encouraged to go on sabbatical, which can be viewed as this cycle for individuals. Departments and programs are constantly being rearranged to create interdisciplinary programs and proto-departments. In addition, it is part of the university ethic that we need to have a diversity of disciplines and approaches, because who knows when one of these ideas might be valuable in the long run. This longer view of value and resources is essential in the creative cycle, but so is the appreciation for the underlying network of

personal connections that support innovation.

## **Conclusions**

1. The real university is the network.
2. This network is supported by many forms of work on a range of scales. Some of the crucial work in universities is subsidized by currency from social reciprocity.
3. Small groups (3 to 5 people) are crucial and yet under appreciated. More people should spend more time with their friends.
4. We all need to be aware of the specific hierarchical projection that is being used by administrators, and understand how that differs from the actual network milieu in which we work and contribute.
5. The creation and destruction cycle needs to be reverently respected. In the long term, leaving fallow resources to support new self-organized innovation will lead to greater institutional health than the immediate exploitation of those resources.



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## Chapter 5: Individual contributions to network health

How many times have you been in a committee discussing the most recent insult to the university's budget when someone suggests a solution based on a project that they are already working on? For example, proposed cuts in the real amount of support available for teaching assistants (maybe because of larger classes) could be ameliorated by more use of peer mentors. The peer mentor idea might be suggested by someone who has students who need some teaching experience as part of their college curriculum. In this case, and many others, a partial response to the external stress (budget cuts) was already being tried out (peer mentoring) for non-budgetary reasons. The previous stress (lack of teaching experience for some students) prepared the system to handle the current insult. The ability of your committee to recognize and implement these changes is an example of how individuals contribute to the health of the overall university. The health of the university is its ability to respond to stress in a beneficial manner.

### 1. Introduction: Network Function and Health

Let's start with the assumption that the set of internal faculty interactions in a university is a major factor in the health of the institution. By healthier, I mean that a healthier institution will respond to stresses with beneficial organizational changes. A weaker, sicker network will respond to stresses by simply increasing the levels of response to that particular insulting stressor.

Healthy complex institutions are able to simultaneously share the stress and protect pockets within themselves. These behaviors lead to organizations that are dynamically adapting to their internal and external environment. This dynamic nature leads not just to resilience (responding to stress) but in developing the university's potential.

There are other indicators of university performance that some might think are related to health and development of quality; leadership and productivity. Leadership is undoubtedly a crucial factor in the ability of a university to deal with problems and improve. Leading a complex institution such as a university however is constrained by Ashby's law (Adams ref \*\*\*) which states that regulation structures must be as complex as the system being regulated. This law means that university administrations and leadership can, at best, hope to guide the complexes not actually regulate them in a deterministic way. The other common index of university health is the production of usable products. Productivity is crucial in any system but the measurement of productivity is problematic. In any complex system there is both internal and external productivity, i.e. there are internal transfers, often messy and difficult to describe let alone quantify, and there are the external products that by definition are packaged for specific users. Any healthy system has to have high productivity, but that it is not necessarily export productivity. This paper argues that understanding how the network distributes internal productivity is crucial in understanding how to nurture university development.

Two metrics that can help define network structure and functions are the "connectivity" and "ascendency". The connectivity is the number of faculty who interact with other faculty with some threshold of intensity. For example, how many other people does one faculty member actually communicate the effort of 1 or more hours of work. Low levels of

connectivity inhibits the spread of ideas and work products, high levels of connectivity spread the work to too many people indiscriminately. An intermediate level of connectivity leads to specific sharing. The value of the specificity of sharing can be estimated by calculating how far away the network flows are from random flows, this is called the "average mutual information" and when related to the total volume of information flow, the "ascendency". For example, if one faculty person shares the product of several hours of work with only 2 out of the 9 faculty in their unit, this is very specific. Random flow would suggest that they share 1/8 of all the work with each of the eight other people in their unit.

*\*\*insert different roles, specify different work products and paths\*\**

## **2. Spatial and Temporal Connectivity Patterns**

Individual interactions that form the connections in a network depend on how the people involved connect with each other, through departmental organization, office space or social interactions. The structure of these persistent relationships can be visualized as a spatial organization or nodes (individuals) and links (persistent relationships). In a typical network, each person has several other people that they work and interact with. Many of the connections are local and people have many more interactions with people who share the same physical (such as a building floor) or academic address (such as a department). There are fewer connections between departments and even fewer across the distance of the campus. There are

only a few people who make connections across discipline or campus distance barriers. It is crucial for the university to have some people who create these bridges in order to maintain a campus with an intermediate level of connectivity.

An intermediate level of connectivity is very important for the network to respond to occasional stresses and perturbations in a healthy manner. I will use the metaphor of a forest and the spread of a forest fire to discuss how intermediate connectivity works. It is important to remember that the perturbation can be either beneficial (such as a teaching innovation), detrimental (such as the loss of a colleague), or a simultaneous mixture of both beneficial and detrimental. At low levels of connectivity, individual areas of the campus are isolated. A perturbation at one node doesn't necessarily have a path to spread to other areas of campus. Isolated areas of campus have to learn and adapt to new ideas and stresses all on their own. On the other hand, if the campus overly connected, any small perturbation at one point spreads through the entire campus affecting everybody. The benefit of an intermediate level of connectedness is that perturbations have some effect, and these are shared in a limited way across campus, but each perturbation still leaves the overall system with a diverse states which is ready to handle subsequent perturbations. Healthy forests with intermediate levels of disturbance are maintained in a mosaic of stages of growth that is not the highest productivity but is the most sustainable form.

The forest and fire metaphor also illustrates that timing is important for network connectivity. After a local forest fire the area is repopulated with grasses and shrubs and eventually returning to trees that provide enough fuel for a fire again. There is a period of regrowth and reorganization during which the system is less susceptible to fire. Faculty have similar cycles in their work. There may be a new innovation, such as implementation of

instructional technologies, that a person launches into. While that person is involved in this new project they are probably much less interested, or even aware of, new innovations. The recovery time period for an individual faculty can be extensive especially under the traditional model where a faculty person is expected to do something then write it up for scholarly review.

Another useful metaphor for the spread of innovation is that it spreads like a disease. Contact with someone is required to catch the disease, but contact doesn't always result in transmission. The potential recipient may have had the disease and is recovering or protected by immunity for some period. Just like a disease, there can be epidemics or small outbreaks of innovation.

Together the spatial and temporal heterogeneity within a university network provides a rich mosaic of states. At any time some faculty involved in highly "productive" activities, packaging products for export. At any time other faculty are involved in reorganizing their assets, in a manner that isn't easily identified as a product. The combination of these states results in a network that has a much more stable and resilient behavior, but at the cost of net export production. These rich mosaics, in nature or complex social organizations, represent healthy mature systems that perform a wide range of internal regulatory and development functions.

Table 1. Mapping specific faculty work activities into the work types proposed by Ulanowicz (1997). Ulanowicz's term for the different types of overhead work are given in italics. The term "overhead" is often used pejoratively by academics, but in networks it is an essential part of work.

Network work categories	Academic Institutional meaning, examples
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<b>Overhead</b>  work needed to maintain the network functions	<input data-bbox="574 195 1253 426" type="text"/> <i>input</i> - The work needed to handle the variety of inputs to faculty. More different types of input require more work.
	<input data-bbox="574 426 1253 615" type="text"/> <i>dissipation</i> - The work needed to support all of the internal transactions of the institution.
	<input data-bbox="574 615 1253 1045" type="text"/> <i>redundancy</i> - In order to survive fluctuations in funding or some other aspect of the university's environment, there has to be some redundancy built into critical processes. The harsher the environment, the more the university has to spend on redundancy.
	<input data-bbox="574 1045 1253 1476" type="text"/> <i>export</i> - After all the other work is done (including ascendancy), the university usually has to produce some products that are valuable outside the system. The value of this exported network work may be repaid to the institution in some other currency.
<b>Ascendancy</b>  work that contributes to	<input data-bbox="574 1476 1253 1728" type="text"/> <i>total system throughput</i> - The operation of the system will lead to higher ascendancy by increasing its total number and amount of transactions.
	<input data-bbox="574 1728 1253 1919" type="text"/> <i>mutual information</i> - The network will increase its ascendancy by increasing the specificity of links between faculty.

the  
network  
itself

*stock accumulation* - The university will increase its ascendancy when there is more intellectual capital stored in long term employees. This capital is available for use by more people over a longer time with less loss to the outside.

### 3. Ascendancy and network development

Natural network structures and flow patterns have been observed to develop over time toward conditions that have both increased flows and specificity of those flows. These empirical relationships have been described with a general parameter called "ascendancy". Ascendancy is the sum for all nodes of the product of the system throughput and the average mutual information (the difference between any specific flow and the flow that would be expected if it were random). Calculation of the ascendancy is explained and illustrated in the appendix.

As systems mature through self-organization, ascendancy increases because of indirect mutualism (Ulanowicz 1997). Not only does a healthy network respond in a moderated manner to disturbances, but small disturbances are actually required to shake loose some connections and allow network reorganization that leads to increased ascendancy. Natural ecosystems progress through succession toward systems that have higher amounts of internal homeostatic controls, higher mutualism and lower export. Ascendancy can be visualized as the organized complexity within the system that helps build these rich system functions. By contrast, overhead includes

all of the functions that must take place for the system to exist. Both ascendency and overhead are required. Overhead functions include handling inputs, packaging exports, dissipation loss and redundancy. The progress of complex systems away from simple maintenance functions to the creation of local wealth in the form of rich mutualistic interactions is captured with a measurement of ascendency.

#### **4. Ascendency Measures of a Model Network**

I'm going to limit the description of calculating the ascendency to just one example of a small network of ten faculty who pass internal work products to each other. Each faculty devotes 10 hours of time to these activities each week and they pass the work product off to some particular person in the network. In this example the total system throughput (TST) is 100 hours of work and it stays at 100. We are only going to explore how the arrangement of the network changes the ascendency.

The calculation of the average mutual information of any particular transaction uses the following calculation:

calculate the proportion of the total flow (flow out of a node divided by TST)

subtract the product of the proportion of that flow out if it were just random times the flow into the receiving node if it were just random

the random flow out of any node is the total flow from that node divided by the TST

the random flow into any node is the total flow into that node divided by the TST

This is easy to do in a spreadsheet table as shown below. Ten faculty people, named A through J, interact by passing work products from one to another. Each relationship from one to another faculty represents a particular flow of work on a weekly basis. In this network, flows back to yourself are not counted.

The right-most column (green) is the sum of all the work that each person produced.

The bottom-most row (light blue) is the sum of all the work that each person received.

The bottom right corner is the sum of all the production for all faculty, and represents the Total System Throughput (TST).

from\to	A	B	C	D	E	F	G	H	I	J	sum produced
A		1	1	3		3		2			10
B	3			2	2		2	1			10
C	1	2			2	1	3			1	10
D	2	1			3			2		2	10
E			2	2		1	3	2			10
F	1		2					2	2	3	10
G		1		1	1	2		2	3		10
H		1	1		2	1	3			2	10
I	1	2	1	2	2					2	10
J			2		2	1	2		3		10
sum received	8	8	9	10	14	9	13	11	8	10	TST=100

The ascendancy calculations for each transaction are the same. We will use

the 3 units of work passed from B to A for an example (red square).

$$\text{contribution to ascendancy} = \text{flow}/\text{TST} - (\text{flow from B})/\text{TST} * (\text{flow into A})/\text{TST}$$

$$\text{contribution to ascendancy} = 3/100 - (10/100) * (8/100) = 0.022$$

The network ascendancy is simply the sum of all of the contributions from all positive flows. A flow of zero has no contribution to the ascendancy. The total ascendancy of this example is 0.451. See the appendix for instructions to create a spreadsheet that will do all these calculations.

The total ascendancy of the network in this example can be increased by either increasing the total system throughput or by making the links more specific. In the next section, we will explore how the structure of the network can increase the ascendancy without increases in any new internal work.

## **5. Comparison of Example Networks to Show the Importance of "Creative Connectors"**

The network structure depends on how individuals pass work products among themselves. We will explore four networks that all have the same total system throughput, but have different structures with regards to the localization and intensity of those flows. The first example is where the flow of work goes to several people in a very uniform manner, everybody produces and receives the same amount of work. The second model has one person receiving a larger portion of other people's work, this person is creating connections that are perceived to be of more value to the producers and they funnel their work through this person. The third model is divided

into sub-units with high flow within units and limited flow between units. These clusters represent departments, sub-disciplines or some other academic or spatial unit. The fourth model uses a creative connector to link these different groups. These models are just examples of the many possible configurations. The point is to show a reasonable pattern of work flow. These models are designed to show that the creative connectors dramatically increase the ascendancy of these networks - from diffuse to collector and from clusters to cluster with a bridge person. If you accept that ascendancy is a measure of the internal mutualistic flows, then the creative connectors are responsible for increasing the value of the network through creating structures that amplify mutualism.

Example 1: A ten person network of work flow. Each person produces 10 hours of internal work that is passed onto colleagues in a even pattern. Each person receives about as much work as they produce. The connectivity in this model is 0.556 *\*\*check this number , is it .500\*\** with each person making giving their work to five other people.

from\to	A	B	C	D	E	F	G	H	I	J
A		2	2	2		2		2		
B	2			2	2		2	2		
C	2	2					2		2	2
D	2	2			2				2	2
E			2	2		2	2	2		
F	2		2					2	2	2
G				2	2	2		2	2	
H		2			2	2	2			2
I	2	2	2	2						2
J			2		2	2	2		2	

Example 2. The same ten person network, but a creative connector, J - green column, has accepted work flow from several colleagues. Person J accepts more work in this network than other people. These colleagues stopped sending some of their work to one place and sent it to the creative collector. Even with this minor diversion in the work flow, the ascendancy increased from 0.500 to 0.530. The connectivity decreased because of the increased specificity of several people (A, B, and C).

from\to	A	B	C	D	E	F	G	H	I	J
A		2		2		2				4
B				2			2	2		4
C	2	2							2	4
D	2	2			2				2	2
E			2	2		2	2	2		
F	2		2					2	2	2
G				2	2	2		2	2	
H		2			2	2	2			2
I	2	2	2	2						2
J			2		2	2	2		2	

Example 3. The ten person network is subdivided into three sub-groups; ABCD, EFG, HIJ. The groups have 80 to 90% of their interaction within the group and the rest between groups. The connections between the sub-groups are weak and distributed to many people. This network has an ascendancy of 0.650.

from\to	A	B	C	D	E	F	G	H	I	J
---------	---	---	---	---	---	---	---	---	---	---

A		3	3	3	1					
B	3		3	3		1				
C	3	3		3			1			
D	3	3	3					1		
E			1	1		4	4			
F					4		5	1		
G				1	4	4		1		
H									4	4
I							1	4		5
J								5	5	

Example 4. The same network configuration as in example 3 except that a single person (person F - pink column) collects the intra-group interactions. This person might be serving as an interdisciplinary coordinator for example. In this new configuration, the creative connector has increased the network ascendency from 0.650 to 0.676.

from\to	A	B	C	D	E	F	G	H	I	J
A		3	3	2		2				
B	3		3	2		2				
C	3	3		2		2				
D	3	3	3			2				
E						6	4			
F					4		5	1		
G					4	5		1		
H						2			4	4
I						2		4		4
J						2		4	4	

These examples show the value that people who can create cross-group

connections can add value to a network. They contribute by organizing the internal complexity in such a way that it promotes mutualistic use of work products. This value is invisible to the export of products from the network to a larger context or hierarchy. In these examples, the total amount of work produced by each faculty person was held constant. The amount of work received by faculty was varied to demonstrate specific patterns of sharing work products. This is a realistic constraint, but often a creative connector can actually motivate another person to provide work products that they otherwise wouldn't have contributed. Such a contribution would increase both the total system throughput and the ascendancy.

## **6. Suggested Methodology for Assessing a Connector's Value (CV)**

The purpose of this chapter is to show that the value of faculty people should be assessed, at least in part, by their contribution to the existing complex network of colleagues. Personally, I am much more interested in how a colleague can help me rather than how valuable his or her scholarly products are to someone I've never met. It is easy to identify and count external products just by their very nature, i.e. they are packaged for external use. It is much more difficult to identify and quantify the contribution of a colleague to your local network's resiliency and creativity.

The ascendancy measures are one avenue to collecting information that could be used to assess some persons contribution to a network. If a map of the current network were created, it could be used to estimate connectivity and average internal work flow. Most faculty would be expected to fall in the average region, probably having several colleagues that they collaborate with and several committees for which they do any significant amount of work. There is nothing wrong with being average, however some people

play special roles in the university that should be evident in this analysis.

Creative connectors should show evidence that multiple people send their work products to them. It would only take a skeleton of an interview to assess which people on committees act as creative connectors. In particular, interdisciplinary programs or even ad hoc projects often have people that collect and synthesize the work and provide a workable context that motivates their colleagues to continue working on the project. The evidence for creative connectors could be obtained by asking faculty who are involved in projects or committees questions such as the following:

How much work did you do on Committee X during an average week?

Who did you send the work to and how was it handled?

Was there anyone on the committee that you think did more work than other people? How much more?

Was there anyone on the committee that provided synthesis and evaluation or put the information in a context that was particularly useful?

If you were to restructure the committee, who would you keep and who would you let work on other projects?

Additionally, similar questions could be asked of interdepartmental programs or to evaluate the effectiveness of multi-investigator grant proposals. There are many arenas in our work in which creative connectors could have played an intentional role in organizing the complexity.

## **7. Temporal Ascendency**

Insert a new section here that describes how to calculate temporal specificity, pulsing, of work products based on the Pahl-Wostl.

## **8. Conclusions**



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## Chapter 6: New products of scholarship

Salmon populations in the Columbia River have been endangered by human activities such as fishing, land use and constructing dams. Scientists from government agencies and the Indian tribe nations spent many years studying and modeling the fish populations. Models that helped visualize the fish populations and simulated the impact of different human activities were a very important part of this study and policy discussion. The way that these models were used however is an example of valuable product of the scholarship. The models were constructed to be used in interactions with the public not just to test hypotheses that would be reported in peer reviewed journals. Scientists would take the model out to people who had many years of experience with the Columbia salmon. They consulted fishermen, wildlife managers, birders, dam operators, and a whole host of people with extensive experience but usually little formal scientific training. They would ask these people, "here is what the model shows happens, does this seem reasonable to you?" Based on the comments that these people made on very specific behaviors, the models were refined and became much more valuable. In essence, the models were a way to help capture the large amount of expertise of non-scientist experts.

The package of the simulation model and its use is an example of a non-traditional scholarly product. The product was valuable (for scientific management) exactly because it was not designed to be peer reviewed, but was designed to be used. In addition, the scholarly product (the model) was designed to be modified as it was used. There wasn't a time before it became public ally used that the model was "completed". Given that the results from the use of this model guided the expenditures of many millions of dollars, you would think that it would be considered a valuable intellectual achievement. But what are the chances that someone who creates a product like this would get tenure. Can you imagine a colleague telling your dean, "I asked some people on the street and they suggested that I make some changes."

## Introduction

In a recent study (Rueter and Bauer, in press), I interviewed many people at my institution to get their views on changes in the definition of scholarship. The focus of this study was to determine whether the expanded definition of scholarship had changed the culture of our institution. The expanded form of scholarship includes scholarship of service, scholarship of teaching along with scholarship of research. Our conclusions were that the expanded definition allowed the university to acknowledge and manage faculty contributions that had been and were currently part of our urban teaching and outreach mission. Interviewees expressed different definitions of scholarship that were personal and obviously based on their own construction of the concepts. The variation in the definitions of what counted as scholarship causes problems for an institution. My efforts to probe the edges of this definition were of academic interest, but for some of my younger (non-tenured) colleagues, probing the edge of the definition is a serious career question that could lead to disputes and grievances procedures.

One crucial piece in the discussion on scholarship and tenure decisions is "what are the products or evidence of scholarly activities?" In the more traditional view the products should be peer-reviewed contributions to the discipline. To some, the products could be much more broad and might include a portfolio of contributions that demonstrate that the person used a scholarly approach to problems. Acceptable products of scholarship and what counts as acceptable evidence for the value of a faculty person is at the core of the arguments in this book. An export model for scholarship needs to depend on external validation and authentication of the products that are disseminated outside of the university's influence. For this model, peer review works to establish trust in the general quality of the products. For

schools in which the network functions are a major asset; work flow analysis, product assessment, and the judgment of colleagues may be more important than external and anonymous peer review. A method or approach to understanding and estimating the value of individual faculty to the network function was described in Chapter 5. This chapter describes different types of faculty work products that could be considered to flow from "scholarly" work by the faculty and suggest ways that these new products can be assessed.

The fact that universities are even wrestling with this question is more evidence that our seemingly conservative trappings (tenure) leads us to be on the forefront of a social revolution. The key question is whether we are stuck with an outdated view of how to build reputation and reliability of information. Howard Rheingold (2002) describes the current social revolution as the shift from traditional linear networks to group forming networks. Linear networks have simple connections that transmit content through a publication mode (one to many). The value of the information depends on its reliability which is established by outside reviewers. A group forming network behaves much differently. The network is larger and more complex. The network is a consequence of social effort to create shared meaning. The groups that form within the larger network are based on trust between the contributors and users in a much more direct linkage. In this social revolution, the way in which we communicate, what we choose to say, and who we choose to talk to are all part of a much more specific way to create valuable information. This communication shift can be visualized as moving from mass publication to targeted messaging, or from self-contained packets of expert information to collaborative works in progress, or from a time-stamped publication to a stream of continually updated information.

*\*\*insert post normal science, broader view of peers, expectation for speculation and judgment, rather than suppressing this with the 95% confidence interval\*\**

*\*\* example of the mad cow episode \*\**

## **Examples of new products and evidence of scholarship**

Five examples are presented below that illustrate a range of products and evidence that could be used. Each one has particular features that make it both very valuable to the local institution but of probably minimal value when judged by anonymous peer review or by traditional promotion and tenure guidelines.

**1. Non-traditional dissemination** - There are many examples of faculty projects that have been communicated through non-peer reviewed processes. There are ways to judge the impact of this material. One example type is the workshops that are given by faculty to other faculty on topics such as teaching methods or using technology in the classroom. The workshops that I have taken and presented were all targeted for the specific audience. Each workshop focused on topics that I thought would be of most interest to that particular audience. These workshops direct the effort of the attending

faculty, in a much more direct manner than reading an article in a peer-reviewed journal. This type of contribution could be judged by how much time the participating faculty spent on this task (in and out of the workshop) and whether there was any measurable change in the participating faculty activity. During my times working with my university's Center for Academic Excellence, we gave workshops and performed this type of assessment routinely.

Other examples of non-standard dissemination are the publication of web-sites that are so complete that they are used as resources for other instructors. These web sites are being continually modified and updated. There is no publication date or reviewer, and yet it would be easy to track users who came back. Given that a academic paper might be published based on the comments of several reviewers and the editor, it seems that user feedback on a web site is just as valid. One example of this is the web-text "\*\*\* statistics\*\*" which is available free on the internet. This web text is required by many courses. If this course counts as a scholarly publication, which I'm sure it does, then it's just a matter of scale to count smaller web sites that are used by tens or hundreds of people instead of thousands.

**2. built in user feedback** - It is common to provide intellectual products to users that includes built in mechanisms for feedback which supports continual improvement. The mechanisms can be as simple as user feedback forms during registration of a software tool or as complicated as take-back programs for physical tools that analyze the failure of the product. Under traditional definitions of scholarship a community of users are not academic peers. Besides being a particularly elitist argument on the face of it, it just isn't the case in most fields that the expertise resides solely in the university.

Environmental databases are a good example. There are established sequences for data entry and quality checking. *\*\*expand on this example\*\**

**3. novel and imaginative projects** - There are some ideas and projects that should be judged based on how creative or novel they are. Departments of fine and performing arts face this situation all the time. The judgment doesn't necessarily have to be on the value of the piece of work but on the potential value of the person who was able to create such an odd artifact. Maybe this is a colleague that you want in your department for what they can add to the mix, not necessarily how much they can produce individually. I've had personal experience with this type of project. In 19\*\* I submitted a paper that brought together two novel ideas, first that some areas of the ocean are iron limited and second that we could fertilize the ocean with ground up desert dust and take up more CO<sub>2</sub> out of the atmosphere than growing a continent of trees. The article was rejected so soundly as to discourage further submission should have been beside the point to my colleagues. They should have looked at that manuscript and decide whether I was someone they wanted lurking around their department. Many years later, 19\*\*date\*\* an entire edition of Limnology and Oceanography was devoted to \*\*the ocean fertilization experiment Iron-Ex\*\*, and a wide scale fertilization experiment took place in the Southern Ocean in \*\*date\*\*.

**4. scholarship in governance** - There is probably nothing more arcane than a proposal for a new course or academic program. In some systems, these proposals are critically evaluated and critiqued by peers. The only reason, that I can see, that these proposals don't count as scholarly works for promotion and tenure is that they are not anonymously and externally reviewed. This is a good example of a product that is obviously scholarly and is extremely valuable to the institution because it will direct many hours

of faculty and student intellectual effort. However, because it is not externally peer-reviewed and published, it won't count as scholarship under traditional definitions.

## **5. acknowledgement of contributions to the disassembly and**

**reorganization phases** - In any of the dynamic networks described in this book, there are periods of restructuring that are just as important as the periods of productivity. Faculty can contribute to these functions in the university through internal reviews, critiques or leadership. A view of a sustainable university that is based on ecological principles is presented in Chapter 8. In this view the university would be a mosaic of communities that are in varying phases of a four step cycle that goes through 1)resource exploitation, 2) resource conservation, 3) release of resources, 4) reorganization of the resources into an exploitable form and then back to 1) resource exploitation again. We currently acknowledge activities that represent exploitation and conservation of resources (such as publications and reviews) but have very little appreciation for scholarly activities that would help departments or disciplines to go through paradigmatic changes and restructuring. In my view in fact, the current set of acceptable scholarly products severely curtails that ability of our departments from proceeding freely through this resiliency cycle because everybody feels they always need to be in the productivity phase. Consider sabbatical proposals; these usually feature lists of products that will be produced when, again in my view, they should be judged on the potential for the faculty person to come back renewed and ready to address novel questions. Sabbatical should be a time for individuals to go through the resiliency cycle at their own personal scale.

## **Criteria and methods for judging contributions**

I think a major barrier to using new products of scholarship that are judged for their local value is simple that faculty don't want to judge each other. This leads to learned or acquired helplessness in which we (faculty) rely on administrators to take the heat of judgment decisions. Many faculty have never been trained how to make a defensible judgment, unless it is along some quantitative dimension with a confidence interval. Other faculty don't want to get into the potential interpersonal hassles that can result from judging a colleague's personal work. While these are understandable barriers, the value of the institution depends on good judgment. Regulation of academic quality is such a complex problem, that it takes a complex set of mechanisms. These mechanisms include the promotion and tenure review procedures at multiple levels within the university hierarchy but also the total involvement of tenured faculty. Whereas tenure is essentially a gift to the administration in terms of cost of regulating a highly complex network, it requires substantial dedication by faculty (See Chapter 9 for further discussion of the beauty of tenure as a regulation device.) Our defense of tenure needs to acknowledge faculty responsibility for judging our peers.

If the scholarly products are going to be judged for their contribution to the local institution's network, then the criteria should weight the amount of work flow and specificity more than it weights an external review. For the institution, the specificity and timing are more important than the eventual publication. For example, it may be just as important that professor X gave professor Y a preprint of a paper that professor Y used in class the next week and was the basis for many hours of thoughtful student work, as it is that the paper was published two years later in a prestigious journal.

Scholarly products must also be considered in terms of their ability to

contribute to continued innovation. As described in Chapter 3, innovation is not just a new idea, but an idea or product that has the characteristic that people are going to be able to use it. A good innovation may not even be a complete or fully finished product. Some very powerful innovations were apparently simple tools, but had the capacity to grow with the user, to be personalized and multipurpose. Whereas traditional scholarly products are usually judged on some level of completeness, innovative projects may be more valuable if they are only partially finished, requiring user activity to complete/customize them. Similarly, a good traditional scholarly product may be judged highly because it answers a specific question very fully, but the best innovative answer may be the answer that is way off target but just close enough that the user sees the connection. This quality of off target innovations are what Hofstadter (1985) calls "slippability" and it is valuable precisely because it is off target for one concept but helps the user link that one target to a much wider range of concepts.

## **Conclusions**

Once again, the underlying creative processes in universities is both on the forefront of a social revolution and creating problems for us internally. While the rest of the population is starting to text message and form groups, people in universities are stepping back from those tools (which we've had for decades) and attempting to understand what they mean. This analysis is causing internal stress as we are faced with a conflict between the traditional products that are based on publishing and external reputation and the new products that derive their value from their immediate and local usefulness. Fortunately for those of us in universities and colleges, this is just the sort of social and intellectual dilemma that we are able to solve. It

may take a while, but the network of you and your colleagues will do the real work that moves us forward.



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## Chapter 7: Creating financially viable regional universities

I recently visited the Johnston Center at the University of the Redlands. This center has a creative structure that captures the most valuable aspects of faculty work and allows students to contribute to the curriculum.

\*\* describe in detail, add reference - McDonald and Ogren 2004\*\*

### 1. Introduction

A crucial problem facing faculty, administrators and all those who depend on universities is how to make them financially viable. Although this is usually seen as a budgetary problem that needs to be addressed at the administrative/hierarchical level, this paper addresses this problem from the network perspective. This network view brings two important points into

focus. First, the current complex network of faculty and staff is already providing a wealth of services, products and creating community assets. The problem is that these valuable contributions may be intangible or not counted in the current management of academic assets. Second, faculty and staff could regulate our own activities in a different manner that would emphasize what we do best. We could probably provide more value to the university, students and community if our network contributions were acknowledge, managed and counted. Bringing these two points into focus simultaneously; we are creating assets that aren't being counted but if they were accounted for they would be easier to manage and exploit. The challenge facing us is not that we aren't creating enough value, it's that much of this value is not showing up on the financial ledger.

A productive natural wetland provides a good metaphor for this problem. It is difficult to place a purely financial value on a wetland, but when it is done, the wetland provides an entire host of ecological services (such as water purification and habitat for commercially valuable species) such that preserving these wetlands provides a very good value in just dollars. Our dilemma, as faculty, is similar to those working to conserve wetlands; we don't want to concede that the wetland can be valued just in terms of dollars, but if we don't make some argument that makes sense to administrators and those with a financial view, we risk loosing the entire wetland.

This chapter has four sections. The first section reviews concepts presented previously that deal with the valuable aspects of a complex network. The second section describes why institutional structures that might be very successful for nationally ranked research universities are inappropriate for regional universities embedded in an authentic community. This section also details why particular assets of our universities are undervalued or even invisible. The third section argues that if we are going to be fiscally viable,

we need to both create the most valuable network and show how this could be counted into the ledger. This third section may seem like it is dodging the initial budget problem by restating it, however, Einstein said "No problem can be solved from the same consciousness that create it." The fourth section constructs a sample budget for an example program that is constructed to create a network for student learning.

### **Section 1: Multiple values derived from a network of faculty**

Current universities provide a wide range of services and help create community assets that are very real, yet not normally counted in a simple spreadsheet of costs and benefits. The local services and creation of social assets is especially true of the regional and urban universities that are embedded in their local communities. This is fortunate, because these universities usually have smaller external (imported) support on which to rely. The recent expansion of the definition of scholarship (as discussed in a previous chapter) was interpreted as an attempt to identify and manage these intangible assets within a university. We need to create a very long list of university services and assets that are available to the community and place a reasonable dollar value on each.

A similar of accounting for "ecosystem services" has been compiled by Costanza and others (\*\*\*\*). This approach determines a value for these services, essentially estimating a cost that would have to be paid by society if this natural system were to be destroyed. A typical wetland or a upland forest provides millions of dollars of services such as water purification and habitat for commercially important species of plants and animals. Their argument is not that everything a wetland does could be replaced by a sewage treatment plant and a park, but that the wetlands are very valuable in

ways that you might not be able to quantify. However, if even if you were forced to pay for only the services that are quantifiable, it would be a very costly proposition.

Our argument as individual faculty and staff in the university should have the same message, the university is more than just a service provider; but if you had to pay for all the services individually you'd see that the amount of money currently being spent is a very good deal. It is important in our argument to establish that many of these services and asset building activities are the result of the network of faculty and staff. The university as an organization, as a complex network of people, functions as a whole unit. In addition, it is crucial to detail how many of these network functions happen because our environment allows for a large amount of creativity from the bottom up, rather than relying only on top-down administrative control.

## **Section 2: Why the current system undervalues network services**

There are many definitions for improving quality and some are more appropriate for some types of institutions rather than others. Research universities, some colleges and institutes have been very successful in improving quality of their programs over the last decades by participating in a "export" economy for intellectual goods. On their playing field of opportunities, publications are related to grant funds which are related to hiring more faculty and graduate students which in turn leads to more and better publications. In the high finance research arena, anonymous review of publications and grant proposals provides authentication of the source that is internationally accepted as a basis for the institutions' reputations. The rest

of the universities in the United States in particular are not players on this field. Instead of mainly serving to export intellectual products, the myriad of smaller universities and colleges, regional universities and urban universities have community metabolisms that have high rates of internal processes that focus more on students or tightly interfaced with their communities.

Individual faculty in these "internal process" institutions play a fundamentally different role than they do in "export" institutions. In Chapter 5, a method for evaluating individual contributions was explored. In Chapter 6, new products of scholarship were described that would build on these faculty skills and efforts and the products could be used as proxies for faculty contribution in internal and interfaced network environments. Not only should the evaluation of faculty value and productivity be understood differently, but the management approach should also be modified. What has been highly successful in export institutions should not work very well (according to our underlying ecological metaphors) in the internal cycling systems. Just as you would rely on different principles to run a successful farm (export operation) than you would to maintain a large wetland (internal cycling operation), the rest of us need management principles that weren't just handed down from research universities.

### **Section 3: Increasing the apparent value of our universities**

If we can convincingly make the argument that the network of faculty and staff create value and community assets through our own self-organization, then we should also be able to manage our own affairs to intentionally increase the value of those aspects of our network. In order to do this, we should pay attention to three things;

- a) understand the products and scales of whatever it is that we

create

b) interact with the community at a range of scales that includes local, small groups and individuals

c) intentionally regulate our activities to span a range of scales

**products and scales-** The value of our network is not only what we export. That is the old economic model of simple and efficient production, not network activity. As explained in previous sections, the network creates organized complexity through both flow and specificity of linkages. There are fewer export "products" of this system that can be easily identified as individual or "atomic" units. Instead we create relationships, partnerships, shared cognition, and a whole host of other changes in both ourselves and those who interact with us. We need to understand our impact and specifically address the gap between the wide range of that impact what is currently counted and rewarded. Our scholarly approach and scholarly perspective needs to be judged much more broadly than the current emphasis on externally peer reviewed, fully-bundled products.

**\*\* example of a product \*\***

**community** - As we explore our impact on ourselves and the community, we need to explore the edges of our institution. The most effective way for us to increase the impact of our qualitative network activities on our community is to feather the edge of our groups into the edges of the

community. We are already doing quite a bit of this type of activity. Community based learning, community partnerships, and other activities are widespread in urban and regional universities. When the interaction with the community at multiple levels are deliberately linked to the curriculum and research, each new relationship that is created refers back to other relationships and to our core activities. The cascade of relationships and inter-relationships provides a border on the institution that is fractal, it expands each time you look at it in more detail.

**\*\* example of a community project \*\***

**regulation** - The process by which we create new relationships in the network needs to be deliberately and thoughtfully regulated. Not "regulated" in a hierarchical sense, but regulation as an activity of the network itself. According to Ashby's Law, regulation needs to be at the same level of complexity as that of the system that is being regulated. This law means that the only way we could possibly regulate the institutional network is through self governance. Our self-regulation toward these goals is actually easily in reach. We don't need to establish rules or structures; in an emergent, complex, self-organizing system, all we have to do is agree on shared values. Individuals working toward these common values will create structures and processes. The front work that needs to be done is to state the university's goals in terms that individuals understand and that allows and promotes individual action.

The following table lists suggested changes that could be made in the structure of a program that would take advantage of the network. For each

suggestion, an example of how this is currently implemented at a university or college is provided to show that these are feasible modifications.

Table 7-1. Suggested changes to emphasize the network value.

1. Redefine "access" to mean access to faculty and to a learning community. Access shouldn't mean that the university has a "take it or leave it" attitude of access to commodity courses. This definition of access moves the locus of the responsibility for learning back to being shared between the student and the learning community, rather than putting it totally on the student. Example: A common current practice is to present students with a list of courses that meet a university requirement. For some of the lower division and non-majors courses, the students are just expected to pick through this list and "take it or leave it". While these courses have value, it is difficult to bring students into the university community through large lectures.
2. Build the program on full time tenure track faculty, full time staff and full time students. Shift from the hourly wage mentality to a salary approach to enable the students to be full partners in the learning network. Example: Almost all of the small colleges work exclusively with full time students.
3. Create connections to community partners that sponsor internships and host learning sessions. These connections will enable students and faculty to expand the network to very specific community partners. Example: Many schools have community based learning or other activities for students as part of the program.
4. Realign accreditation of the degree to be more based on the judgment of faculty of students' performance and work products and less along the lines of credit hours, seat time and collections of interchangeable course units. Relying on judgment and evidence provides the type of accountability that is superior to current assessment methods. This judgment is rather easily performed by networks of faculty but difficult in an input-export model. Example: Force the student to create work products that are judged by small groups of faculty and peers such as is done by Hampshire and other schools.
5. Pay attention to the architecture of the educational setting, in particular providing spaces for all sizes of groups from classes of 40, to seminars, to medium and small groups. These spaces should all be in the same physical location and visible to each other. There is an incredible amount of meta-information available about the network just by observing who is talking with whom and what is going on in different project groups. Example: Architecture departments have studios that have many projects in different states of completion, all in common view.
6. Allow more flexible time scheduling for courses and work such that specific work can be as short as as long as it needs to be. Network specificity through temporary pulses of highly focused work. Example: Many campuses have very successful inter-terms that allow students to focus on one topic for a short time.
7. Create a faculty to staff to student ratio that reflects time spent by each in different size groups, not just classroom settings. \*\* expand this idea \*\* Example: Universities have always had courses, labs, recitations and advising at different size scales.

These general suggestions demonstrate that there are relatively minor adjustments that could be made that would enhance the value of the network and make a stronger connection to the operational budget of the institution.

## **Section 4: Example budget for a self-sufficient program**

The strongest argument for realigning the processes of the institution to fit with the budget would of course be an example of an institution that became more profitable. To my knowledge, this doesn't exist. Instead I will present an examples of traditional program compared to a "networked" program. Both of these examples will be highly simplified but they will be built on the same assumptions of the total amount of work and quality of work that faculty and students do. The comparison will focus on how building in some variability to the "networked" curriculum allows the potential for more specific information flows and simultaneously for cost savings.

**Traditional courses** - For comparison, let's examine an example traditional program. The values that I have chosen seem to be about right for my institution. Below is a list of assumptions that hold for this case:

- the average class has 20 students
- students take four 4-credit courses per quarter or semester
- each faculty teaches 2 courses per term
- it takes about \$100,000 per year per faculty for salaries and benefits

In this traditional scenario, students would need to pay \$10,000 per year just to cover faculty expenses (it would take 2 faculty equivalents to meet a student's four courses which would cost \$200,000, divided by 20 students per course = \$10,000 per year per student). One hundred students attending for full-time for a year would simply require 10 faculty, with a total personnel cost of \$1,000,000 per year.

A typical student's week might look like the following:

14 hrs per week in class  
2 hrs per week in the library  
6 hrs per week in lab  
20 hrs per week homework and studying

---

40 hrs per week total

A typical faculty's week might look like the following:

8 hrs per week in class  
7 hrs per week of lecture preparation  
5 hrs per week of lab preparation  
10 hrs per week grading and assessment  
10 hrs per week of individual research

---

40 hrs per week total

Of course there are no typical or average students, but these time budgets are instructive. The students spend half of their time doing homework, usually by themselves. They spend a good portion of time in class with 19 other students. Faculty devote only 1/2 hr per week per student in direct student feedback but 30% of their time (15 out of 40 hours) preparing for and working in a classroom setting.

The flow of work products is not very specific (Figure 7-1). Students prepare for class and create work for their instructors but many times these are routine assignments that are the same for all students. Some courses might entail intensive writing with individual feedback but, even though

these are very valuable, they are rarer because they take so much faculty time. Faculty feedback is minimal on an average weekly basis (1/2 hour per student) because it is often concentrated on exams or papers. In addition, the work product flow is very homogeneous. All courses look about the same in terms of total work and they have the same schedule. If each faculty treats all of his or her 20 students equitably then each student will also get the same amount of feedback. The network view from any student or faculty is essentially the same as any other student. The network is made up of totally replaceable connections.

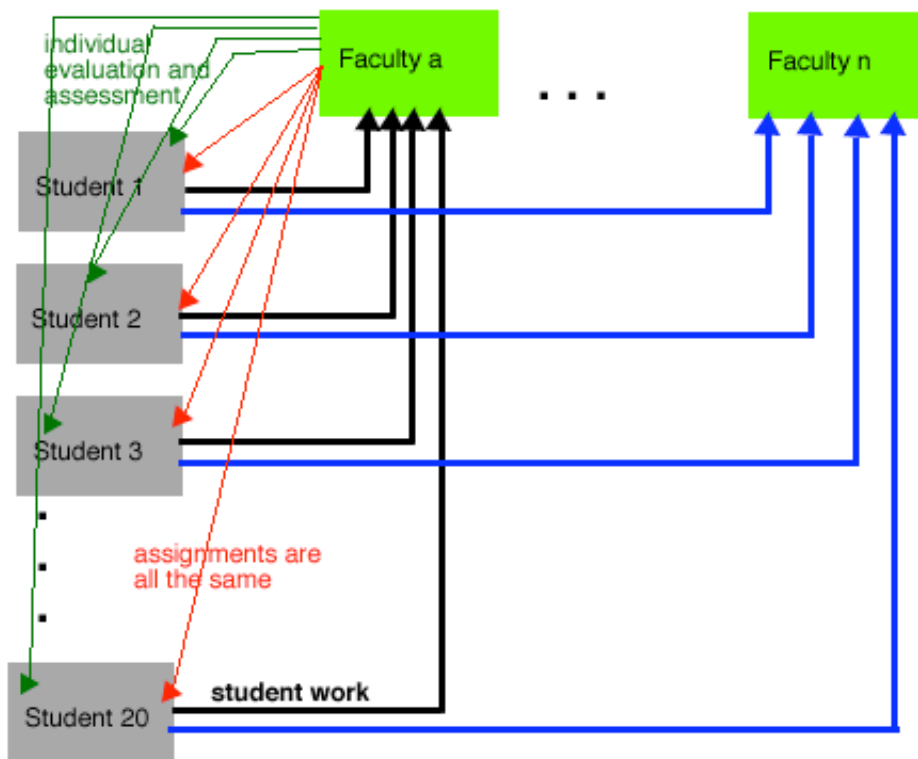


Figure 7-1

Figure 7-1. A diagram of the work flow in a traditional curriculum. Each student sends work to the faculty and each faculty sends work to students. The assignments are the same to all the students but the feedback, assessment and evaluation is specific to the individual student.

**Networked curriculum** - Using the guidelines described in this chapter and in previous chapters, it would be possible to revise the curricular structure such that students took different types of courses. The design principles should be to maximize the specificity of information flow between students and faculty or between students and each other, peer mentors or graduate teaching assistants. The following model illustrates how the student's experience could be modified such that they have a range of activities and that these activities have a range of scale in the number of people involved and time that the activities take. The networked curriculum described here should increase the specificity (in content, audience, and time) of the flow work products. As described earlier, increased specificity can be measured with the ascendancy index. The assumptions, typical work loads and a description of the structure are given below in a parallel manner to the description of the traditional curriculum.

- students have different size meetings and classes that range from one-on-one meetings with the faculty, undergraduate mentor or graduate teaching assistant
- students take 16 credits per quarter or semester
  - one traditional class (4 credits)
  - one small project course that lasts for a term (4 credits)
  - one large project course that lasts all year (3 quarters or 2 semesters) (6 credits)
  - one college-wide visiting seminar series (1 credit)
- each faculty spends the same amount of time teaching but has a different mix
  - some traditional courses
  - some short project courses with a peer mentor

some long project course with several other faculty and a graduate teaching assistant

- it takes about \$100,000 per year per faculty for salaries and benefits  
undergraduate peer mentors get tuition remission  
graduate teaching assistants get \$15,000 for salary and benefits and tuition remission

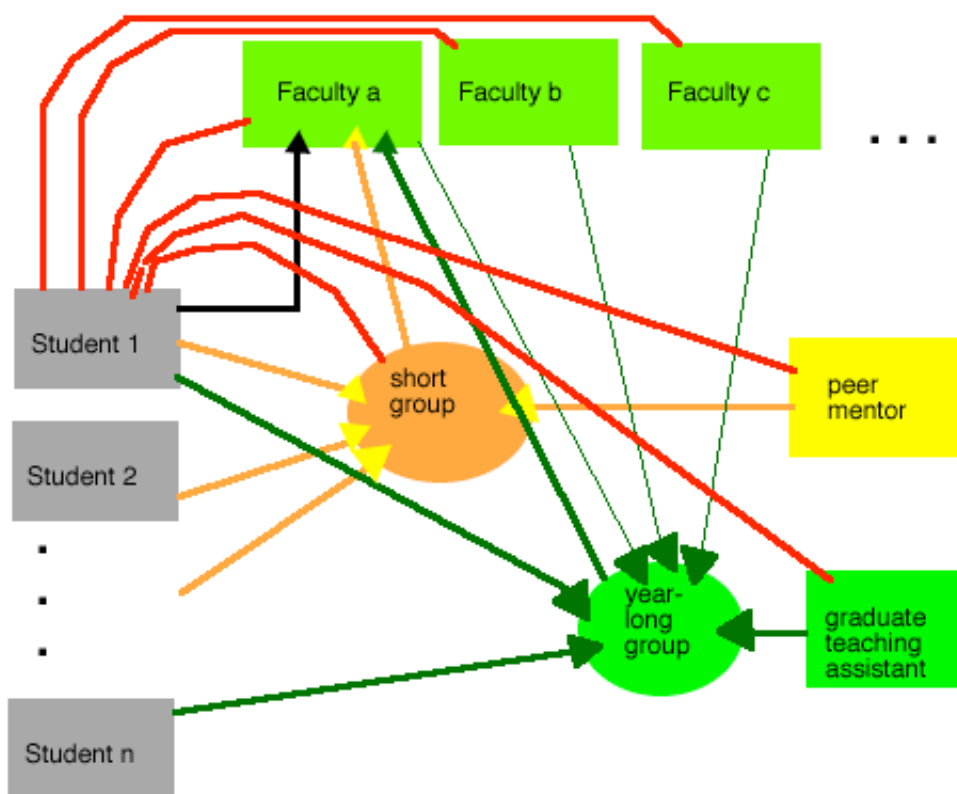


Figure 7-2

Figure 7.2 A diagram of a networked curriculum that shows only one corner of the network. As opposed to the traditional curriculum, students would receive a variety of feedback from faculty, their short and long term groups, from the peer mentor and from the graduate teaching assistant. The composition of their traditional class, short project group and long project group would be different, allowing

much more diversity in the types of connections that they have. The work that is produced for the three types of courses would also be different on different time schedules, allowing for highly specific and focused pulses of work and feedback to take place.

In this "networked" curriculum it is more difficult to calculate the cost per year because there are more roles for faculty. The following calculation is based on 100 students as above.

5 traditional courses per term at 20 students each	2.5 faculty
5 short term projects	5 faculty 5 peer mentors
2.5 long term projects	2.5 * 1/3 fac 2.5 grad TAs
1 or 2 large format guest lecture series	

The total personnel would be about 6 faculty, 3 graduate teaching assistants and 5 peer mentors. The cost of these would be \$645,000 and there would be 5 undergraduate and 3 graduate tuition remissions. I will assume that the graduate tuition is twice the undergraduate tuition. Thus the tuition cost is calculated for the student who pays tuition, i.e. not the 5 peer mentors, and has to also generate enough to pay for the graduate student's

$$\text{tuition\_per\_student} = (\$645,000 + 6 * \text{tuition\_per\_student}) / (100 - 5)$$

solves to be \$7,247

which is almost a 27% savings in tuition for students.

Thus, this proposed solution provides an increase in the network function (ascendency) and a cost savings. Abstract network function metrics may not be motivation enough to make such a structural change, but certainly attempts should be made to allow faculty to contribute more while saving money.

## **Conclusions**

The university is a complex, self-organized network that provides a wide range of services, products and creative relationships that are valuable but not usually account for in the current financial ledgers. Universities provide a high value in public goods compared to the cost.

Through self-governance and, in particular, redefinition of scholarly products and values, this complex network could create more value for the community. Management along the lines of these products can increase the apparent value, compared to managing for export production only.

The network approach to restructuring curriculum could allow faculty to do more of what they do best. Gross metrics of network function (such as counting hours of interaction between faculty and students) could eventually be replaced with measurements that assess the value of those interactions and the targeted flow of information.



# Net Work:

complex networks do real work within universities

Draft v 3.0

## Chapter 8: Faculty work at a sustainable university

**\*\*insert story\*\***

**\*\* notes for this chapter**

maybe use the term "sustainable health"

urban renewal, purge the chaos and inefficient markets

now we see a decision to go back ??

goal should be the sustainable health of a complex institution, not a

minimum level of impact

## **Introduction**

All those who aspire to sustainability will sooner or later have to deal with the issue of limiting their physical growth and focusing on growth in other dimensions. Not everybody believes this statement. There are some who think that unlimited substitution of goods and technology will eventually fill in our material and economic needs. But even suppose these people are right, why shouldn't we increase access to quality first and then grow in size?

Simply, growth in size is not a sustainable strategy, it is a market capturing strategy. No aspiring university administrator wants to be the one who passed up the big chance to expand their research, teaching or distance education program during the first decade of the millennium. They all seem to want to sell the very attractive idea that we can be bigger and better.

Even though the fight against the popular attraction of expansionism requires a solid proposal, I am floating these ideas as a beginning of the discussion. I hope to show in this proposal that continual improvement of the university is inseparable from the nature of faculty intellectual work and that the work that needs to be done for improvement is done by the network of faculty and professional staff.

## **Part 1: Sustainable Development of Quality, Not Size**

The non-growth scenario for development requires building, deconstruction and reformation. A useful framework for this has been proposed by Gunderson and Hollings (2002) with variations by Ulanowicz (1997). The description of an system (in their case both natural ecosystems and human socioeconomic systems) includes four main facets:

1. exploitation of available resources that builds order and capacity
2. modification in the system that uses these resources most efficiently given external constraints and competition
3. disassembly or destruction of this order
4. reorganization and reforming of these resources such that they are available for subsequent exploitation

Comparing these phases to the metaphor of a small part of a forest; 1) a bare patch of soil in the forest, plants and eventually trees grow rapidly to fill in the bare soil, 2) the forest matures that structure becomes more set and all the resources have been sequestered into the forest, 3) a fire or storm disturbs the little patch, liberating resources that were sequestered in the trees, and, 4) the microbes in the forest floor and soil regenerate a pool of nutrients that are available to support another round of tree growth. Then the cycle starts over again.

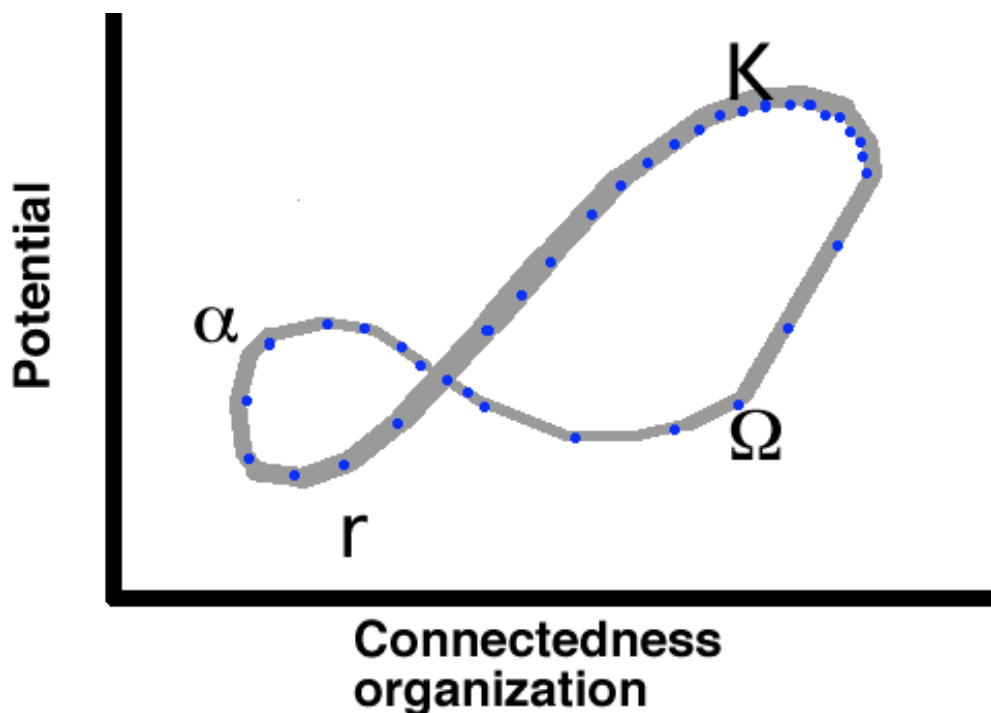


Figure 1. The cycle for development (as adapted from Gunderson and

Holling, 2002) has four phases

1. **r** is a period of rapid resource utilization that includes increase in the size of the network
2. **K** is the region in which competition for resources leads to efficiency and eventual brittleness of the system
3. **W** is the breakdown of the structure built in the **r** and **K** portions to liberate materials that can be used subsequently
4. **a** is the period in which the resources are transformed, reorganized, or concentrated such that they can be used.

The blue dots represent equal time intervals in an example cycle. Much more of the contributing systems would be in the productive "front loop" of **r** and **K** than in the creative "back loop" of **omega** and **alpha**.

An example of this cycle in an academic environment could be:

- a group of faculty create a curriculum that keeps adding new small courses,
- after a while there are so many courses that they take up all the time and space in the departmental labs and classrooms,
- a committee is formed that suggests totally revamping the curriculum to have fewer but longer courses,
- the department goes through a transition that frees up space and faculty teaching time to offer these totally new integrated classes with laboratories.
- the number of these courses increases gradually and the cycle begins again.

Another example could be at a different scale entirely. A new building is built that has state of the art facilities. These facilities are modified and renovated for a period of time but finally there is a decision made that the old building will have to be torn down and an entirely new building will need to be constructed.

Thus, as academics we are familiar with the basic cycle of exploitation, growth, disassembly and creative reformation. But, in order for this to work in a sustainable

university, the cycle needs to be taking place at multiple scales and asynchronously. Creative renewal at one scale draws innovation and support from other units on campus at the same scale (such as the individual faculty member or department) and sustenance during the period of reformation from scales above. These are crucial points that are worth amplifying. Individuals and departments are part of a network that is undergoing change. Part of their effort at anytime is to help support other parts of the network that are going through creative reformation. This support can be in the form of the flow of ideas and innovations, but another key aspect in a sustainable institution is to leave raw resources alone. A department that is redefining itself maybe going through a period of lower measurable productivity or "efficiency" but it should not be punished financially. The second point that needs amplification is no less than the reason for the university in the first place, to accumulate and localize wealth and resources for the purpose of supporting units undergoing creative reformation. \*\* reference to quote in Rheingold about civilization in 7 words \*\*. It should be expected that the university will accumulate financial resources that will be reinvested totally in the participating departments. The accumulated wealth will not be used for growth, special programs or other initiatives. The support for those initiatives may be important but needs to come from a different source.

## **Part 2: The multiple types and time scales of faculty work**

A sustainable university has to be simultaneously working on many time scales. Fortunately for university administrators, the intellectual work of faculty, that makes up the most important aspect of the university's function, already comes in a wide range of types and scales. The instruments already exist for implementing this type of change. Skillful administrators should be able to orchestrate a viable process. For example, the university can respond to student demand very quickly by offering new courses and at the same time, these new courses can be part of a thoughtful migration of the departmental curriculum toward a new area. Just as the curriculum should be

more than just a checklist of courses, curriculum development involves processes at multiple scales. Individual faculty and committees simultaneously work at this range of time scales.

Individual faculty are each involved in a variety of work activities that result in identifiable products, such as a "course" or a "research paper". Similarly faculty are involved in networks of other faculty, and although they create some particular products in these networks, they also do some crucial work on which the network itself depends. Attempting to understanding these different types of work done by networks require that we try to identify characteristics of pieces of this work.

Ulanowicz characterizes the work the is done in a network as either "overhead" or "ascendency" (Table 2). This is a potentially valuable way to view the different components of faculty work, i.e. do they contribute to maintaining the system as it is, or can their contributions be used for further organization or adding value to the system. It is extremely important that we remember that even though we might be able to categorize types of network work, individual faculty work activities can simultaneously contribute to multiple network work categories. In fact, Ulanowicz (1997) claims that in a healthy network there will a few, longer-lived compartments with a slower turnover time because this configuration is able to concentrate the elements that are most crucial for the network's function. This is the ecological solution to the "mixed unit problem" that is discussed more in Chapter 9. In our academic networks, this means that it is healthy to have a sizable cadre of tenured faculty and long-term professional staff who are able to retain large quantities of the intellectual capital that the university has developed to make itself work.

A healthy network of faculty, administrators and staff will have a combination of overhead and ascendency work being done. There is nothing wrong with doing "overhead" work and it can't be interpreted that improving the value of the network (ascendency) should be left to the elite. Quite the contrary, maintaining and building the network is part of all activities by all individuals. It should be that in a healthy university network the individual tasks that we perform would be part overhead and

part building. For example, faculty would use their intimate knowledge of the curriculum and how it was developed to advise students, not just for today but for the direction of the department in the next few years and the discipline for the next decade. Similarly, advising staff would use their well-developed set of connections to guide students through the academic curriculum while being aware of co-curricular and extra-curricular activities that could be beneficial for the student's degree and career.

### **Part 3: Guidelines for building a valuable network**

A healthy network of faculty should have the following characteristics; 1) the network should support individual faculty activities and well-being, 2) the network should do the required work to maintain the university, 3) the network is able to do the work of constructing and revising new portions of itself, and 4) the network should respond to stress in a manner that leads to a net improvement.

The university should be a place where individual faculty contribute on multiple scales and the tasks create value for themselves and their associates. Although this view might be commonly held by teaching and research faculty, I doubt that those people who consider themselves industrial "clients" or student "consumers" would state the purpose of the university in this manner. A self-referential mission is a crucial piece of creating the demonstrable value of faculty work. My view of the entity of the university is very different from the market model where faculty cede the responsibility for value statements to students and other clients of their work. A sustainable university must have values that are intrinsic, not reacting to market pressures. *\*\*insert expanded definition of the importance of self-referential statement\*\**

*\*\* insert notes on purpose of people and the network \*\**

A healthy network of faculty and staff should be able to support all of the necessary functions of the university. The overhead of doing business with students and other users of our work can be accomplished in load. Because of the integrated nature of faculty work, where teaching, research and community service and university service are all based on inter-related constant and context. For example, advising and assessment efforts are directly related to the teaching expertise of each faculty and their knowledge of the curriculum.

#### **Part 4: Valuing faculty work**

I am arguing that the work being done at a healthy university has three characteristics:

1. A university is a highly dynamic and complex network that is continually working to maintain, build, break-down and reform itself.
2. All of this work is occurring all the time at different time scales (individual faculty, department and college).
3. Faculty and staff activities can accomplish all these forms of work as integrated tasks.

If all of these types of work need to be done, then they must be equally valuable. Some activities may be more apparent through some filters and some activities may be almost invisible if working properly. For example, when a faculty person brings

in a large grant this is a very visible piece of evidence for that faculty person's effort, creativity and diligence. There is nothing wrong with celebrating these accomplishments. However, when multiple, integrated activities of caring faculty, advising staff and peers keep ten students from dropping out, this "non"-event is probably invisible.

Some types of intellectual work are more visible than others. Again, imagine you are wearing your dollar filter lenses, everything is in shades of dollars. Large research grants in the sciences are easy to see. Contributions to pedagogy, critical theory or understanding of social systems are lightly shaded and blend in with the background. Many of these contributions can be so woven into the fabric of the institution that they are essentially camouflaged to people wearing their dollar lenses.

The intellectual work that needs to be done by faculty for sustainable development of the university falls into the phases presented in figure 1; exploitation, organization, creative destruction and reformation of resources. Exploitation is taking advantage of resources to build more capacity and productivity. Organization is the type of work that adjusts the system to work in a competitive or resource limited environment. Creative destruction is the breakdown of organized resources at a larger scale (discipline, department or college for example) to make them potentially useful by individuals. Finally, reformation of the resources is the work that it takes to prepare the resources such that they are ready for the exploitation phase. A crucial point in my argument is that these four phases are required for sustainability. In a simple growth only mode, the university would rely mainly on the exploitation phase with a little conservation phase being required. In the growth mode, only certain activities are viewed as being valuable faculty work.

Universities have a distinct advantage over other institutions in that we have disciplines that can contribute to all phases of our sustainability. Although each department needs to go through the cycle eventually, the discipline expertise in some discipline can be brought to bear in understanding and guiding the cycle for the rest of the university (Table 1).

Table 1: Intellectual contribution to understanding of the four phases of the sustainable renewable cycle.

phase	disciplines	contributions
<b>r</b> - exploitation	natural sciences business engineering	identify new opportunities build on those
<b>K</b> - conservation	business engineering	work in a competitive environment identify constraints
<b>W</b> - creative- destruction	humanities	critical theories longer time scales
<b>a</b> - reformation	arts education business	new ways of seeing resources building knowledge systems innovation

## Part 5: The role of the university

Universities all have a wide range of disciplines that represent different world views. This is important as described above and outlined in Table 2. Second, faculty work at traditional universities takes place on many scales; annual teaching loads, sabbatical rotations, tenure decisions, multi-year committee assignments, within and across departments, university wide and others. The faculty are the embodiment of multi scale work that contributes to both overhead and ascendance of the university. Third,

there have been patterns of curricular restructuring that look like the sustainable cycle.

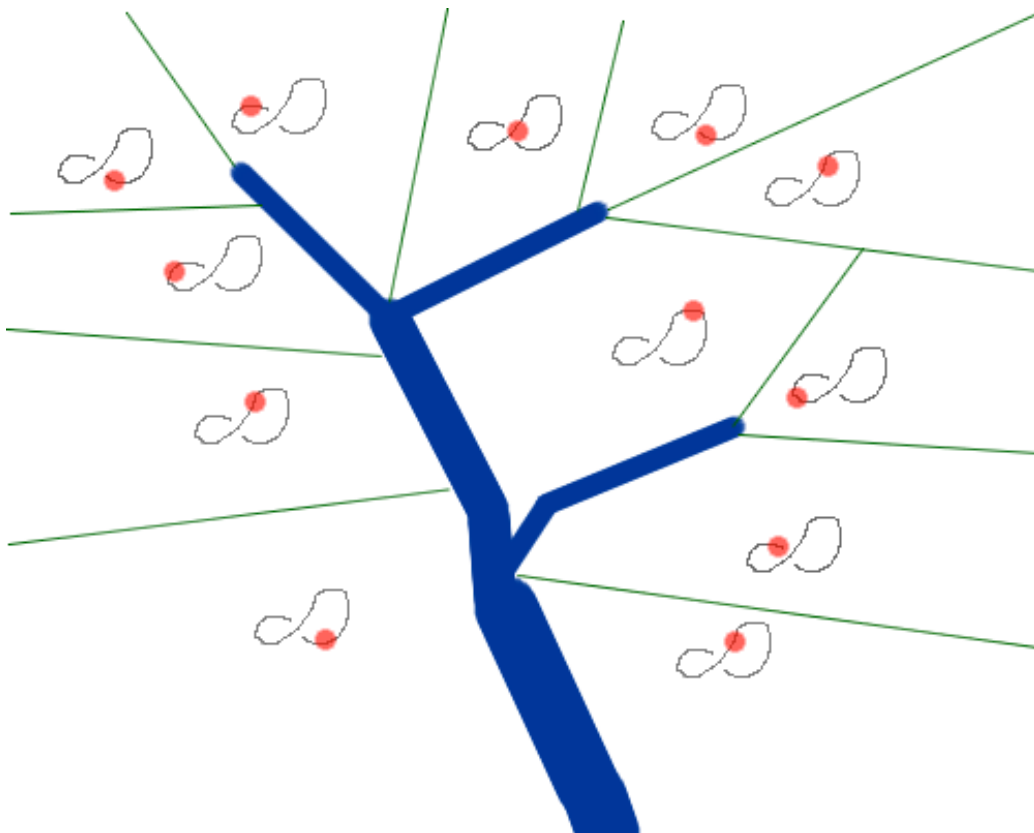
Our modern universities are some of the healthiest institutions that humans have constructed. They have weathered the storms of financial and political crises in many different countries. In fact, universities have contributed to social changes in many countries, with very different governments, for example compare the critical role of universities on Viet Nam protests and Tiananmen Square demonstrations.

I don't believe any of the current market-speak analysis of universities. Universities don't need to be more "open to change" or more "nimble". They have adapted to continual change. Our structures and rules contain ambiguity that keep us constantly off-balance, out of equilibrium, and ready to make adjustments. Universities don't have to more efficient. As explained above, output productivity only even makes sense for just one part of the overall cycle. Finally, I think the drive for accountability is more about counting than responsibility. Faculty and staff are very responsible already. They are constantly in contact with students and members of the community. It is a fine line between this warping of accountability into countability to task-management. I just have to ask, in whose world would we pay more attention to what "the market" says than to the experiences from our culture or the voices of "thinking and observant people". Just about the time that our parent societies are clawing their way up the beach of a post-materialist era, valuing our environment, families and culture; our universities are considering major steps back into the materialist, primordial ooze, valuing only money and what can be bought and sold.

In my view of a sustainable university the administration plays many crucial roles. One role is "enlightened stewardship". They are responsible to make sure that the accumulated resources of the faculty and staff network at the university are maintained for future generations. The other crucial role that they play is navigation through the uncertain landscape of the future. These two roles are very difficult together, they need to maintain resources in the face of continual change. Managing the resource allocation so that portions of the university are constantly undergoing

renewal cycles requires a sense of history and the future. The metaphor for this type of system management is the milpa cultivation system in a river basin. At any one time some tract is being exploited while others are going through the rest of the cycle. The global view of this requires administration to deal with the fundamental culture of creativity and renewal.

Figure 2. Milpa cultivation in different areas of a watershed (adapted from Gunderson and Hollings, 2002). Notice how all the areas are in different parts of the renewal cycle. This is proposed as a metaphor for university development. The entire watershed (the university) is divided into small regions (departments) that are each in a specific phase of the renewal cycle.



\*\* insert

listen to the culture

local wisdom - certain pastures were cultivated because there was an overall beneficial effect

upstream - downstream, for example, erosion in one drainage could lead to higher productivity later downstream

### **Conclusions: characteristics of a sustainable university**

A sustainable university will be constantly building and reforming itself at multiple scales. Faculty and networks are responsible for the work that it takes to do this. Healthy work activities contain elements that contribute to both the maintenance and increase in quality of the university. (The alternative statement: The degradation of the faculty work environment occurs when the amount of work done just to maintain the institution, i.e. strictly overhead works, increases.)

A sustainable university will value faculty work from a broad range of disciplines because these are equally important in the vitality of the institution. (And the alternative statement: A growth university will over-value disciplines that contribute to exploitation).

A sustainable university is an institution that accumulates financial wealth during programs' growth phases and distributes this to departments who are in restructuring phases. A sustainable university will invest in faculty development rather than only new hires and departmental reformation over program growth.

The degradation of our work environment that we are perceiving now is an unavoidable consequence of the "growth" paradigm. First, simply the increase in the size of our university network leads to an increase in relative proportion of overhead vs. ascendance of the network. Second, the focus on productivity and efficiency

places extra value on the pieces of our work that can be judged quantitatively. This emphasis can result in a fragmentation of our work experience. Thus, both size and fragmentation lead to higher perceived proportions of maintenance work. We are drones in a bee colony and are restless because we don't feel like we control the quality of our lives.



## Chapter 9: The beauty of tenure

\*\* insert story - beauty and health are related \*\*

### Introduction

My argument for tenure is simply this; if we wanted to design a mechanism in an organization that would support continued creativity and independence it would look just like tenure. Long-lived organisms solve three crucial problems for complex networks whether the system is a swamp, an old-growth forests or a university; 1) the "mixed-unit" problem, 2) over propagation, and 3) how to put the selection process at the logical level.

Each of these is a detailed argument based on the functioning of effective complex networks. Together, these form the basis for why tenure is beautiful; it is a proven process that runs itself, replicates itself and yet maintains a level of complexity that constantly makes the outcome interesting.

There are many objections to tenure. Tenure has financial ramifications, both beneficial and costly. These objections won't be dealt with here mainly because I don't think that we are properly valuing faculty work in the first place and these issues were dealt with earlier (see chapters 5, 6 and 7). There are ways to measure the contributions of individuals to the health of social networks, other than just by their export productivity (Chapter 5). An important improvement in our ability to manage complex academic networks will be to accept new products of scholarship as evidence for faculty value (Chapter 6). Recognizing and valuing faculty contributions to a healthy network is the key to establishing financially viable regional universities and colleges (Chapter 7).

It seems that there are two issues that really bug "managers" or "administrators" most about tenure. The first is that tenure somehow protects "dead wood" in the system. I couldn't have picked a better metaphor myself. From the point of view of a complex old-growth forest, the dead wood is one of the crucial components for the health of the forest. The reason the "loggers" don't see its value is that all the activity is underground and happening at scales and in pulses that take some level of sophistication to see. I think that if the internal aspects of faculty work were made more visible, the productivity issue for many of these faculty would take on a different complexion. I am not claiming that there aren't some free riders, but I think even that problem can be more profitably be addressed by looking at the potential internal contributions these people could make.

The other complaint that many administrators seem to have is that tenure is stochastic, i.e. that it contains random and uncontrollable parts (along with the highly selective parts.) For these administrators (who play crucial roles in universities) I will present methods by which they can control the process at the appropriate level. The appropriate level for administrators is to limit their dealings to the financial responsibility hierarchy, and not encroach on guessing about creativity. This is not to say that administrators don't have good intuition or gut feeling about creativity, but it is to say that the current list of proxies for faculty value that are being commonly used are neither "intuitive" or "visceral". It is not valid to simplify the criteria for the tenure decision down to a list of quantifiable proxies for the very complex realities of faculty work.

Tenure has persisted because it provides a middle way between the dangers of oversimplification and the need for simplification in order to make decisions. The tenure arrangement promotes a complex internal network structure, and that network solves key problems for administrators. In the face of industrial, reductionist, and mechanistic metaphors pushing for clear lines of command and efficiency, tenure is simple, organic, elegant. As Bateson observed (2002, page 5), there

"seems to be a law of cultural evolution according to which the oversimplified ideas will always displace the sophisticated and the vulgar and hateful will always displace the beautiful. Any yet the beautiful persists."

## **1. The "mixed unit problem"**

The difficult questions facing ecologists have always been:

What processes should be studied?,

What is the most important process?

If more than one process is studied how can the relative contributions be compared?

For example, which element cycle should you study; carbon, nitrogen, phosphorus, iron or some other trace metal. If you can afford to study more than one element and energy, how do you compare their relative value. For example, how do you determine the relative value to the ecosystem of another mole of nitrogen or iron? The real complex network of organisms in their chemical and physical environment, processes element and energy flow continually and continues to build and develop the network itself. Ecologists call this dilemma the "mixed unit problem".

The way the network itself solves this problem is by having a range of life-cycle lengths and long term participants in any community as crucial players. The trees in the forest time-average over days, seasons and decadal oscillations. These long term residents help provide a matrix in the physical-chemical-biological environment that allows the network to develop higher quality, for the network to increase its ascendancy.

The lesson here seems to be obvious; faculty and long term staff are the trees in the forest. But the heuristic value of the metaphor is richer than that. The natural ecosystem network develops through stages that have decreasing export and more internal functioning. These internal functions increase the network's value to itself, i.e. increase its ascendancy. The ecosystem provides some export to the external environment and receives input from other locals, but as it matures and develops, the ecosystem becomes more self-reliant and resilient. Thus the lesson is also about the level of export

relative to the development and who benefits from internal cycling versus export.

## **2. Barrier to over-reproduction**

The process of natural selection contains two important parts. The most familiar part is that there is a process of selection that acts on individuals who are not as fit as their competitors. The less familiar part is that even though particular genes are amplified in the population through selection, there is still a very large random library of genes that can be passed on. This random component is very conservative. No new genes need to be created for this process to work. Genes from previous generation are mixed in different ways. There is no process by which a successful individual modifies his genes and dominates the next generation with those self-modified genes. The dominant individuals have a selection of genes that they received from past generations. This conservative step is crucial in the long term creativity of the system. The current fitness landscape can't eliminate all the genes for other traits. No single strategy can completely dominate the next generation's genotype.

Faculty hiring, development and tenure have similar characteristics. There have been academic trends that sweep through our universities with variable frequencies. The saving grace for our institutions is that there is always a reservoir of the conservative elements. Tenure of faculty ensures that the next generation of trends can't just wipe out or replace entire lineages to previously successful strategies. The reorganization that takes place in universities after these trend waves pass relies heavily on all of the knowledge assets of an institution, including the traditional and novel

mixtures of traditional and new ideas.

### **3. The locus of control is of the appropriate logical type**

*\*\*insert references to Bateson\*\**

I think the most important function that tenure plays is that it establishes a very complex mechanism for self-regulation that is embedded in the faculty network. The system needs a mechanism at the level of faculty to faculty and needs to provide faculty with tools to judge work of colleagues. It is important to put this control into the context of the entire power structure of the university. Tenure is not an external regulatory control, where information from the level of faculty-faculty interactions (i.e. scholarly exchanges) are used as a decision process from another level in the hierarchy (such as the hiring and firing in departments). The power hierarchy of the university can set the criteria for the export productivity, but it can't be involved in the process of selection. Tenure insulates the administration from having to get involved in the faculty-to-faculty level.

The locus of control is important for all three parts of this argument. The point here is that it is to the administration's advantage in a situation with tenure, not to have to deal with the inner workings. The disadvantage, of course, is that they have to know how to guide the system externally. This is actually very complex, requiring complex processes and is done by the other tenured faculty. The complexity of regulation (in an internal control sense) is handled as one part of the real work that is done by the complex network

that is maintained by faculty.

*\*\*insert - consider adding a section that analyzes the power necessary to control a system, as done by Adams \*\**

## **Conclusions**

Tenure is associated with the healthy resilience of universities, just as long-lived organisms are a crucial part of complex natural ecosystems. Tenure leads to a combination of a large random pool and selection steps that, in turn, support tenure. This self-organizing system displays a form of internal control that favors mutualistic solutions and leads to effective development, even in the absence of growth. Administrators and other parts of the university's power hierarchy can have control over the context of the system but need to avoid direct contact with faculty-faculty interactions on scholarship. Tenure provides the isolation required for control and tenure is an essential and undividable piece of that organic control.

If administrators had to regulate faculty creative contributions using only mechanistic tools of management, it would take a large amount of energy to be focused on each situation. The focusing of this amount of power would actually create another type of problem in itself. Managing the direct and side effects of management control efforts could become the bulk of the problem. Just as farmers moved to dealing with growing crops to managing their wastes and toxics, industrial management would evolve to controlling damage and limiting dissipative loss. In terms of the amount of resources that it would take to control faculty creativity and to control the controlling

processes, tenure is almost free. Tenure is a gift to administrators, freely given by the complex faculty network.



# Net Work:

complex networks do real work within universities

Draft v 3.0

## Chapter 10: Using ecological principles to manage networks

**\*\* add in story \*\***

**\*\* add in to the chapter**

management goal is to acquire and use resources, individuals have purposes

define "purpose"

creating heterogeneous texture in the "landscape"

- a. slight variations
- b. only applying low energy

my two principles for managing complex systems

- a. use a limited amount of external force
- b. work with the purposes of each individual

## **Introduction**

A manager is any person who is trying to set conditions that will improve the performance of the network. Obviously this includes administrators but it also includes faculty who are working in the larger context of the university or college. These faculty or staff people could be involved in crucial committees, active in faculty governance or members of a union representing academic employees. All of these people will be trying to improve their college or university through activities that they think will provide leverage for improving quality.

There are many definitions for improving quality and some are more appropriate for some types of institutions rather than others. Research universities, some colleges and institutes have been very successful in improving quality of their programs over the last decades by participating in a "export" economy for intellectual goods. On their playing field of opportunities, publications are related to grant funds which are related to hiring more faculty and graduate students which in turn leads to more and

better publications. In the high finance research arena, anonymous review of publications and grant proposals provides authentication of the source that is internationally accepted as a basis for the institutions' reputations. The rest of the universities in the United States are not players on this field. Instead of mainly serving to export intellectual products, the myriad of smaller universities and colleges, regional universities and urban universities have community metabolisms that have high rates of internal processes that focus more on students or tightly interfaced with their communities. Individual faculty in these "internal process" institutions play a fundamentally different role than they do in "export" institutions. In Chapter 5 a method for evaluating individual contributions was explored. In Chapter 6 new products of scholarship were described that would build on these faculty skills and efforts and the products could be used as proxies for faculty contribution in internal and interfaced network environments. Not only should the evaluation of faculty value and productivity be understood differently, but the management approach should also be modified. What has been highly successful in export institutions should not work very well (according to our underlying ecological metaphors) in the internal cycling systems. Just as you would rely on different principles to run a successful farm (export operation) than you would to maintain a large wetland (internal cycling operation), the rest of us need management principles that weren't just handed down from research universities. *\*\*is this last bit too redundant to earlier chapter?\*\**

This chapter has three sections. The first section briefly reviews the important characteristics of self-organizing networks that are resilient and healthy. This section addresses how to create conditions that promote an internal network at a university, being cognizant that actions must be at the level of support or infrastructure rather than to structure any particular details of the network itself. The second section addresses how to enhance or repair a portion of a network. For example, a manager may have to help a

department recover from some external or internal stress. The final section gives recommendations about how to learn about complex systems (such as faculty networks) and how to make decisions in a complex landscape.

## **Creating conditions for a healthy university**

There are several principles that govern the construction and operation of biological ecosystem networks. The basic principles of self-organization and ascendancy were presented in Chapter 2 *\*\*insert more details\*\**. Chapter 3 provided some examples of how academic networks are extremely valuable for spreading innovation, distributing risk and providing resiliency for the overall system. In addition to these lessons about how networks perform, it is important to remember that there are different logical levels of control for different parts of the network *\*\*insert an expanded review\*\**. For faculty level creativity, the locus of control needs to be embedded in the faculty network and, in fact, insulated from the simpler hierarchical controls of university finances. However, there are other aspects of faculty and staff work that have to be managed more directly. I am claiming that the key to creating a healthy university is to manage the infrastructure, support and resources of the university such that they support, not degrade, the faculty network.

Administrative actions should create an environment in which the activities in the network are reinforced. Administrative actions and choices can be viewed to fall somewhere on three axes, and choosing the appropriate tradeoff will provide either convergence with or stress on the actions of the faculty network. The art of administration is to be able to judge when to amplify through convergence and when to push with a little stress. The three axes are; export vs. internal recycling, mutualism vs. competition, and

specific tasks vs. general values. *\*\* insert a figure ? \*\**

As discussed earlier, tracking only export productivity may not be a good match for the real amount of work that needs to be done in regional universities and colleges. The question is when incentives for export products are valuable, and this has to be addressed in a case by case basis. It should not be assumed that export incentives are good to neutral because they may actually damage the performance of some sub-groups. It is important to consider that if export incentives do rule the day, they may distort the rest of the structure of support and resources. For example, small stipends for summer research may actually suppress the risk taking that is necessary for longer term success. Minor stress or distortion may provide diversity and create new niches for academic opportunities. A large grant to one discipline may create new opportunities in those departments but at the same time stifle, because it undervalues, other research. For example a large grant to study the molecular biology of plants may be very advantageous to biology but may disrupt equally creative work being done on the social equity issues around genetically modified foods. This is particularly the case if the department competition for space and attention is based on external funding. *\*\* I need a better example that shows how incentives can warp the network\*\**

The value for export of intellectual productivity is closely related to competition. Internal and external competition for grant support or access to resources is most often based on the level of traditional, exportable products of scholarship. There is a tradeoff between faculty time spent on producing intellectual products for general distribution (through journals or other dissemination avenues) and faculty time spent producing work that is specifically targeted for a network peer to use. Some incentives might be able to promote the mutualistic relationships between faculty, staff and

students to each produce what they can do best. At the extremes there is a big difference between a piece of work that a faculty produces that is sent to a journal that no one else in the institution reads compared to a piece of work that was crafted for an internal curriculum analysis. With a broader definition of the products of scholarship (as suggested in Chapter 6), it will be easier to recognize and acknowledge internal contributions.

Tasks definitions are often set by the hierarchical power and resource structure. These tasks are passed along down the hierarchy to other parts of the network. In my experience these tasks are defined in the context of an outlined set of goals, objectives and action items such as might be constructed by a SWOT analysis (Strengths, Weaknesses, Opportunities, and Threats). The structure of the task, as assigned, assumes that the problem has already been solved and it is merely an implementation issue. Although there are probably many instances where efficient implementation is desirable, there are also many situations in which the creative power of the network is being ignored. The alternative management strategy is to present the issue as a pattern that needs to be solved. Alexander (1979) and Alexander et al. (1977) describe patterns as consisting of a broader context, the forces that are in play, and the how these will be resolved. At the free form end of this spectrum, the challenge is to understand the stresses and opportunities and to come up with solutions through adaptation, innovation and invention, i.e. let the network solve the problem. *\*\*insert Ostrom - social institutions solve dilemmas\*\**

### **What you can do to enhance or repair sub-networks**

Consider the scenario that you are put in charge of helping a department develop their potential to contribute to the university, or that a department

has had some trouble. In approaching this problem, there are some basic principles that you need to remember. First you should perform an initial scan of the department's network characteristics including their internal and external (gross) productivity, the matrix of the flow of internal work products, and the actual density of work being done. For example, in a dysfunctional department there maybe very little internal work being done. This will set a limit for the rate of change that is possible. Second, you need to remember the principle of dissipation (mentioned in Chapter 2). You can't apply more force to this system than it can reasonably dissipate, otherwise you will dramatically change the nature of the problem. Applying more external force (even in the form of subsidies or incentives) won't help reach a solution more quickly, if that solution is to be a self-healing reorganization process. As an administrator, this might try your patience. Third, you need to look for points in which the work flow could be made more specific. Are there faculty who could collaborate effectively over a short time to create a working document? Such an intense collaboration is and example highly specific work flow. In these systems, it is important to pay attention to the temporal dimension. It may be possible to get little pulses of work that are very intense and specific. This might be a good place to start. Fourth, you should consider the scales of the problem. How does the problem that this department faces change when you consider it at time scales of days, terms, or multiple years. How does the problem differ from the points of view of small sub-groups of from 3 to 5 faculty? These different time and group scales can be used to construct a plan for reorganization that has different groups going through the different stages of the resiliency cycle at different times. It may be possible, for example, to get one sub-group to focus on increasing student credit hour generation, another sub-group to make improvements on the current curriculum and a third sub-group to consider totally rewriting their portion of the curriculum. These represent several steps in the resiliency cycle. The final point you will want to consider is how

to set up conditions such that the internal network, once reformed has sufficient complexity to be self-governing.

*\*\*elaborate\*\**

The main role that an administrator should play in this situation is to filter the interactions with the rest of the university. An administrator needs to practice selective communication to protect the department from some university forces while letting others pass through. They will need to assign, in the context of the legitimate power and responsibility hierarchy, authentic tasks. The tasks could have the following characteristics:

1. The tasks need to reinforce internal mutualistic relationships and sharing. These could include a degree of uncertainty, such that they have to rely on innovation rather than previous patterns of social collective behavior (Valente 1995 - pg 5)
2. The tasks should be addressed by self-organized working groups (Arrow et al. 2000). An environment needs to be established such that the other people in the sub-network can trust this group to do the work (without requiring representation from all interested groups). The entire sub-network will get to work on and revise these group projects in the future.
3. The tasks should be addressed by working groups or interest

groups in the faculty that have a direct stake in the solution. The project time line needs to allow for deconstruction, protect from resource slippage to other groups during reorganization, and the manager needs to acknowledge early progress in exploitation of the new resource that was created.

4. The tasks should be seen as a mosaic of states in which some are in different stages of the resiliency cycle, but most should be in exploitation or conservation.

As the manager you can allow for a range of types and frequencies of pressures or stresses to hit or not hit the group. It is important that you impose a slow drift of the parameters that you want to use to increase the quality. By slow, that means that any change in these parameters need to be slower than the time it takes for one revision and test cycle of any faculty activity. For example, if you are trying to encourage curricular revision, the underlying quality parameters need to change slower than the several year cycle it takes for proposing course revisions, testing and implementing final changes. The manager acts as a filter (for the period of change) to environmental stresses, allowing some but not all stresses to propagate. The stresses that do hit the group should include many small stress and fewer medium size. Only larger stresses that don't exceed the power density limits of the network to respond should be allowed to pass through. Again, all these stresses must be authentic stresses that are being experienced by other parts of the entire university.

Finally, the department must be reconnected to the rest of the university. This can actually be part of the authentic stress - creating a more connected curriculum for students. The connection should be on multiple levels, UG curriculum, grad curriculum and faculty collaboration. These connections

can be used as types of stresses/opportunities that can be reintroduced during the process.

## **Learning about complex systems and making decisions**

Making a decision about the strategies that you might employ in managing a faculty network is the same as making a decision about any medium sized complex system (Rueter 2004). The decision process requires that you learn about the system, first understanding it and then studying it. Then, the type of decisions that you can make and the type of outcomes that you should expect are different than in deterministic or causal systems. Administrators who have academic backgrounds in the deterministic disciplines may have to build a repertoire of new metaphors just to start looking at the problems as a complex system. Most importantly, in direct contradiction to the old saying, "if you're not part of the solution, you're part of the problem", with complex systems of medium size, you're always part of the problem.

I have five basic components for learning about systems that show complex behavior. These principles shouldn't be confused with steps, but should rather be seen as approaches that will contribute to your being able to understand complex behaviors. The first three components are necessary for you to be able to understand a complex system and the last two components are important for studying these systems. These five principle components are:

- 1) You need to develop a large repertoire of metaphors that can be applied to complex systems. The metaphors are important both for identifying complex behavior with a structural system and as heuristic devices that help you focus on the similarities and differences between the metaphor and the

observed system.

2) Everybody needs to experience the rich and thick nature of complex systems personally. These immersion experiences should be real and messy enough to convince you that resulting models and analysis of complexity are a necessary academic simplification. The experiences should also allow you to practice and refine your innate abilities to sense (on many levels) the patterns that exist.

3) Simulations, either as multi-player games or interactive computer models, can help you get a feel for the multiple possible paths and outcomes of these systems. The simulations can also be a way to create data sets that can be analyzed in the same manner as real world data.

4) You need to observe and collect data from systems without the biases and filters imposed by deductive, general laws. Multiple opportunities (and sufficient amounts of time) need to be made available for students of complex systems to observe, analyze and then re-observe with their new "eyes". It is never truer that you don't wade into the same stream twice.

5) You will make relationships within the data to create information which will then be examined for relationships. This component of the overall process may require a range of data analysis and visualization tools. Visualization tools that are shared with the simulations should be especially powerful.

Actual decisions in complex systems will have to be driven more by empirical data and inductive reasoning than a known set of possible events and outcomes. The scale of the decision is a critical part of the decision itself; if the system is either small enough to be dominated by the decision maker or large enough to be insensitive to the decision maker's choice, the

decisions can be simplified into a game style choice. If however the system is at an intermediate scale there are many actions that the decision maker can take that will actually help determine the fate of the system. For example, an actor could choose to demonstrate that a particular process is feasible even if it isn't economically sound. Such actions can lead to alternative paths including some that might have positive feedback effects.

## **Conclusions**

**\*\*learning\*\***

**\*\*understanding, definition of Perkins\*\***

**\*\*making decisions under uncertainty in complex systems\*\***



## Chapter 11: Parting Shots

Although the previous chapters are liberally sprinkled with my opinions, this last chapter is pure opinion and speculation. I don't want any reader to go away thinking, "that was interesting, but what does he really think?"

### 1. Power and creativity

The hierarchy of the university controls the power relationships and the creativity comes from individuals and small groups. Creativity, and thus small groups in particular are under appreciated in the structure. Gains could be made by promoting small group interactions.

**\*\* the hierarchy needs the network for dissipation of power in a controlled manner\*\***

**\*\*Adams, too much power fundamentally changes the problem\*\***

## 2. Valuing faculty products and services

The overall network functions to develop internal functions that are both more productive and have high specificity. The network as a complex system, selects for increased ascendancy because of the benefits of local mutualism. The contribution of individuals to this overall network function can be modeled by subtraction analysis. Subtraction analysis is when a single node is removed and the value or role of that person is inferred from the change in the overall network functioning. Internal processes in the network include scholarly activity that is not being measured in the current export and peer review model.

New products of scholarship need to be considered. There is currently a dissonance resulting from the collision of waves from new business and communication models being used by the university as they collide with the standing waves of traditional "products of scholarship". This tension should lead to the reorganization of our shared ideas about scholarship and about academic management. I think that some academic leaders will hold tightly to the traditional criteria of the past until their position becomes brittle and tenuous. This will set up the conditions for a series of broader changes in academic structure. These changes may be sweeping. It seems counter-intuitive, but experience with other systems indicate that strong traditionalists enable radical change. If traditionalists want to avoid regime shifts, they should help expose the network to a range of scales of authentic stresses.

*\*\* rat breath hypothesis \*\**

*\*\*manage for resiliency not stability\*\**

### **3. Financial future**

*\*\*this section in particular needs editing and condensing\*\**

Universities are complex networks of faculty, staff, students, administrators and other participants. The network has organized itself over the last decades and will continue to self-organize unless we impose unreasonable constraints or overwhelming stresses. The most unreasonable constraint that is being imposed is the Taylorist drive to modify our teaching and course offerings to produce the most student credit hours. Although student credit hours converts to revenue, restructuring the teaching process just to meet this demand is inappropriate in that it is an attempt to regulate the network at the wrong logical level. It is tinkering with the mechanics when the problem is much larger. The path to financial viability is to figure out how to value the current wealth and services of academic networks. Any simple approach, such as student credit hour generation, is just not a complex enough strategy to work with a complex network (Ashby's Law).

Additionally, no one can ignore the importance of revaluation because if we don't become fiscally viable our academic institutions will face increasing financial stresses.

University faculty will only be able to take some responsibility for financial viability of their institutions when the true total value of the faculty activities are part of the accounting system. Slight modifications in educational accounting could help emphasize the added value (as student learning) that

faculty provide. As long as higher education continues down the path of commodification, the experience of learning and the value of faculty networks will be under-valued and universities, as they are structured will not be financially self-reliant. However, unhealthy institutions with shallow and simple networks will be competitive in the commodity market. Bowing to this trend will destabilize higher education in total. Its time to realize the responsibility of a profession, i.e. university faculty needs to own up to our responsibility to regulate our industry. Credit mills must be aggressively sought out and discredited (as the Oregon attorney's general office has done). Our individual institutions need to cooperate with this effort to maintain our oversight of what transfer credits we accept.

**\*\*expand, easy courses within our walls, credit agreements, for example 4 cr of graduate credit just tacked onto a course if you pay for it\*\***

#### **4. Sustainable development**

It seems as if everybody wants to be sustainable and to have sustainable growth. There is no such thing as infinitely sustainable growth, but there can be sustainable development of quality. A sustainable university needs to develop the quality, not the size, of its faculty and staff network. People need to be given the flexibility and time to go through the entire creative cycle, including periods of export, competition, destructive creation and reorganization. A sustainable university should be a mosaic with pockets of production, reorganization, maturity, and even little bits of chaos.

If American universities became sustainable enterprises, this transition could catalyze a radical shift in businesses practices that explore the "prosperous way down" described by Odum and Odum (\*\*\*\*).

## **5. Tenure**

Tenure is a beautiful process. Tenure is crucial in creating local controls over faculty productivity that are in the proper context and logical frame. Counterintuitive, the conservative aspects of the tenure process lead to continual creative health of universities. Tenure is so beautiful, that it should not only be maintained but that if other sectors of the economy recognized its benefits, they would adopt similar processes. I'm not just saying we are smart to use tenure for managing our complex systems, I'm saying that business sector is dumb if they don't get a little more complex and a lot less simple.

## **6. Academic management**

I used to think that the image of a dean "herding cats" was funny. Now I realize the appropriateness of the image; cats (and faculty) are inherently independent and weakly domesticated. The only cats that you really get to control are the fat, Purina-dependent lap felines.

The key to management of complex systems is to understand the appropriate logical level of control. The hierarchical power structure gets to set the

conditions and authentic financial requirements. It is not appropriate for the hierarchical power structure to set details on how the network of faculty and staff will meet the requirements. Practically there are many procedures that need to be followed for student registration, course management, classroom scheduling and others. \*\*add in here \*\*

The main problem that I see is one of scale. Universities and all the main divisions within the university are too large to be effectively managed by any single person. Just as I see that the future of American agriculture will be highly specialized and profitable small farms, I am even more convinced that parts of the university need to be managed by highly skilled and intelligent people at a more local level. Faculty should be involved in several different networks that may focus on teaching or research such as departments or research centers, respectively. Each of these departments or centers should be small enough that the administrative leader has an intimate knowledge of everyone's work and a total picture of how all the pieces fit together. \*\*use Gladwell's nomenclature for a bridger? \*\* In the complex network view, it is crucial that we return to a scale in which some of us can hold a holistic view of our work. If the units get too big, even the leader has to simplify their understanding to see only the outputs or projections of the characteristics along some management dimension. Instead, the faculty involved and the leader of the unit should be immersed in the messiness of a complex system and when they have to abstract some aspect of the internal workings out onto some arbitrary dimension, that person knows that there is much being left out. This is just basic of modeling. We model complex systems so that we can use the information from the model to make decisions about the original system. I feel that because of the scale we are forgetting this basic logic; we are managing the model as if it is the system.

For example we have simplified the description of disciplines, learning objectives and outcomes into a model, but we are managing the model - not using the model to inform us how to be intelligent parts of the system.

## **Appendix 1: Calculating the Ascendency Index**



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