



West Texas A&M

U N I V E R S I T Y

Systems Assessment of Systems Program

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Systems Assessment of Systems Doctoral Program

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ABSTRACT: Systems PhD students in the capstone course chose as their term project to apply systems methodology to analyze the program they were near completing. Students looked at the interaction of the various components of the program and studied the impact on the final product: them. Not only were the students fully engaged providing an insightful assessment, they engaged their peers and the faculty in an ongoing discussion resulting in significant alterations of the program. The presentation will provide a template for similar analysis by those most vested in the program – the students.

RATIONALE: Assessment of academic programs is often performed by select groups of faculty within the program using a variety of instruments including student evaluation, alumni evaluations, employer evaluations, and faculty evaluations. For the most part, student participation is limited to direct response on student evaluations and indirect measures of program success through student grades, graduation rates, and job placements. All of these measures are important and useful but neglect the potential for the students to directly assess the program in which they are participants.

The assessment method to be described is an outgrowth of the capstone of the doctoral program in systems agriculture. As a course requirement, students are required to perform a systems analysis of a meaningful problem. Since the PhD program is in its formative stages, the students chose to use systems methodology to assess the program. They developed an overall conceptual model of the program with which they evaluated the multidisciplinary nature of the program and interactions between diverse components. As a subset they evaluated subject matter content and levels of understanding within the core courses and other program requirements.

They found development of the necessary causal loops helped identify both strengths and deficiencies within the program. As might be expected, the students became fully engaged in the assessment, but other students and the faculty observed carefully. Findings of the student assessment have been helpful in refining program objectives and adjusting the curriculum to meet those objectives.

The session will be directed toward development of a systems approach for assessment with emphasis upon the experience with the PhD program at West Texas A&M University. The assessment provided better insight into how material from one course impacted the understanding in another course in an unrelated discipline and highlighted the importance of communication between faculty of all disciplines.

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EXPECTED OUTCOMES: By using a systems approach, we are better able to understand the interaction of various components with the system. The expected outcomes of the approach are

1. identify weaknesses and strengths within the program
2. identify interactions between various components
3. improve the program
4. increase student engagement because students are actively involved in identifying needed improvements using a systematic, rational methodology
5. increase faculty engagement through involvement with students because faculty recognize the assessment is the direct outcome of their effectiveness at achieving program objectives

ACTIVE LEARNING STRATEGIES: Program participants will develop a simple causal loop diagram and will become engaged in active learning through their own analysis of the program model. The program model will be presented with opportunity for participants to consider how suitable that model is for their program. Program participants will be encouraged to actively participate in discussion of the subject matter content and levels of understanding identified in the program assessment.

BRIEF BIOLOGICAL SKETCHES:

Dr. Robert E. DeOtte, Jr. is an associate professor of environmental engineering with the Department of Agricultural Sciences at West Texas A&M University. He recently became the graduate program coordinator and director of the doctoral program for the department. He previously directed the hydrology program at Tarleton State University and before that worked as a research engineer for the Texas Engineering Experiment Station.

Mr. David Lust is an instructor of animal science with the Department of Agricultural Sciences at West Texas A&M University with interests in all livestock species and a commitment to effective teaching for undergraduate students. Mr. Lust was one of the students involved in the program assessment and a driving force behind that effort.

Dr. Donald R. Topliff is a professor of animal science and associate dean for the College of Agriculture, Science, and Engineering at West Texas A&M University. Dr. Topliff served for 10 years as head of the department of agriculture and was instrumental in receiving Texas Higher Education Coordinating Board approval for the doctoral program in systems agriculture.

Dr. Clay Robinson is a professor of soil science with the Department of Agricultural Sciences at West Texas A&M University. He was the graduate program coordinator when the assessment occurred. He is committed to improve teaching effectiveness and actively engage students in all levels of courses he teaches.



Systems Assessment of Systems Program

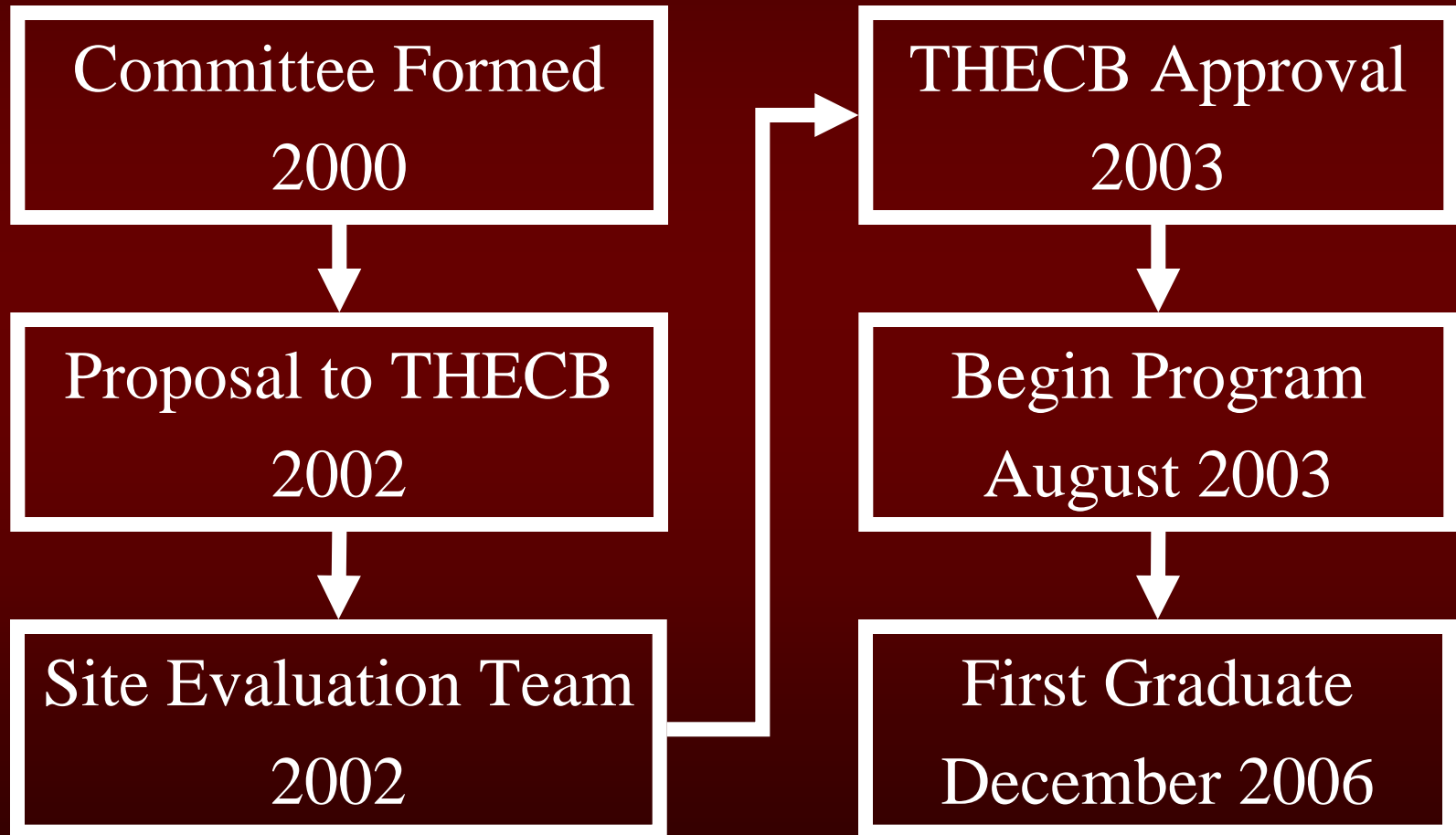
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Program History



Program Learning Objectives



The purpose of this program is to prepare leaders for the agricultural industry that are trained in a multidisciplinary, research-based curriculum that emphasizes a systems approach to problem solving. To meet that purpose, the following educational objectives have been established:

- **Develop a rigorous course of doctoral study that integrates the various agricultural disciplines into a focus on contemporary issues in agriculture.**
- **Educate agriculturists that have a breadth of knowledge and experience in various agricultural and economic disciplines and the ability to apply a systems approach to the solution of challenges faced by agriculture.**
- **Provide the advanced multidisciplinary and industry interactions and education required to develop leaders capable of addressing social, economic, global, and environmental issues to sustainable agriculture.**

Curriculum



Core Courses - 15 SCH

- Systems Agriculture I
- Biotechnology in Agriculture
- Advanced Statistics
- Agriculture Perspectives on Environmental Risk
- Systems Agriculture II

Controlled Electives - 18 SCH

- Two courses each from
(At least one at 8000 level)
ANSC / PSES AGBE

Seminar

(Leadership)
1 SCH

Research

Up to 18 SCH

Dissertation

12 SCH

Assessment:

Continuous

Evaluation and Improvement



Better & Better



Begin PhD
Program



Program
Quality

Program
Changes

Assessment

or Worse & Worse

Better & Better

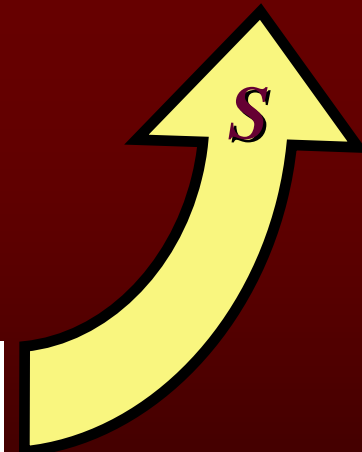
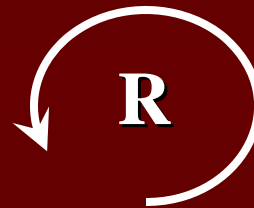


Begin PhD
Program



Program
Quality

Program
Changes



Assessment

The loop with R
in the center indicates
a reinforcing action.

Polarity S indicates the response
at the arrowhead is the same
direction as the driver. A polarity
of O would indicate response in
the opposite direction.

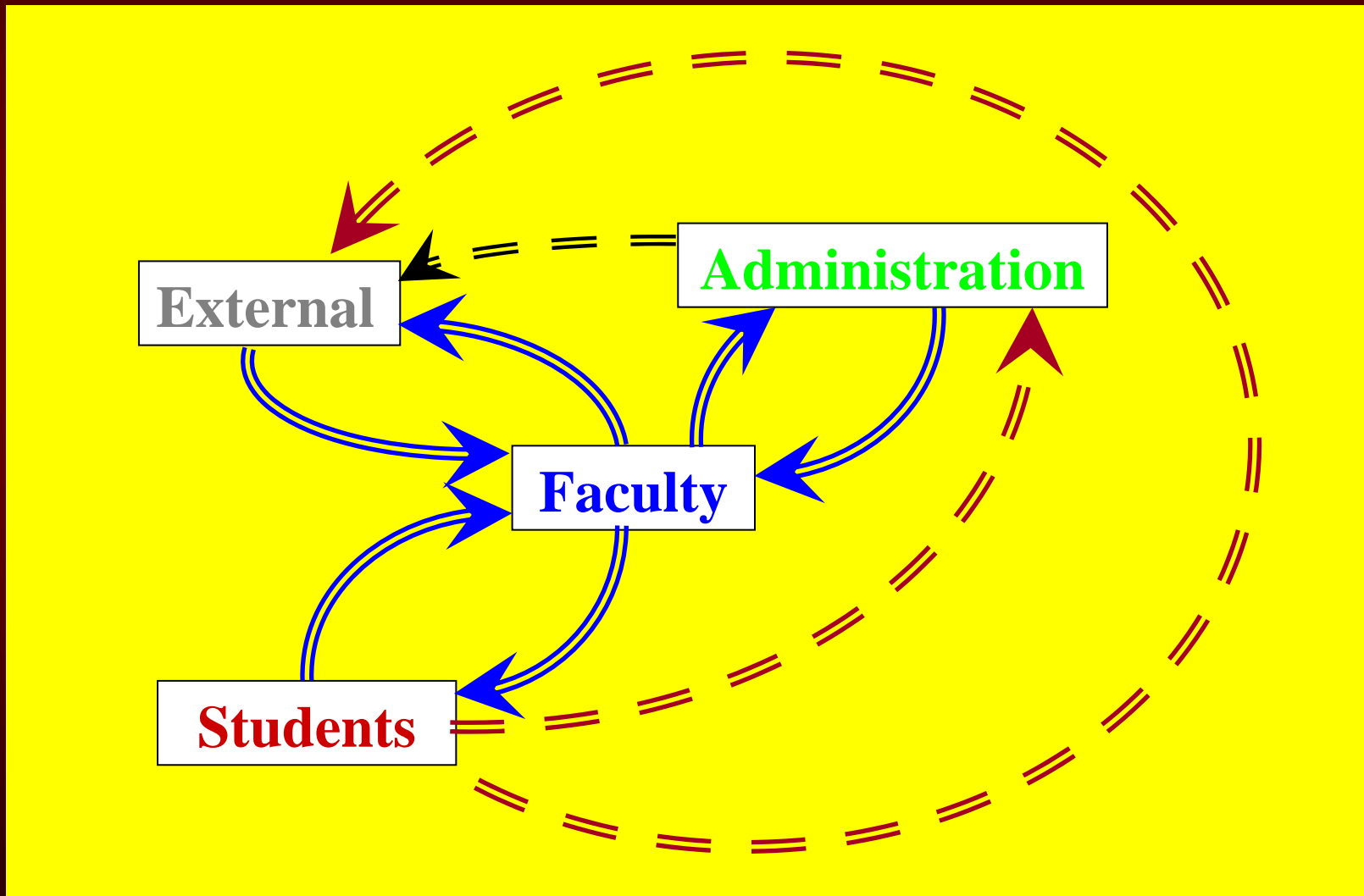
or Worse & Worse

Program Assessment

- Purpose
- Requirements
- Student Engagement



WTAMU PhD Assessment Interaction Diagram

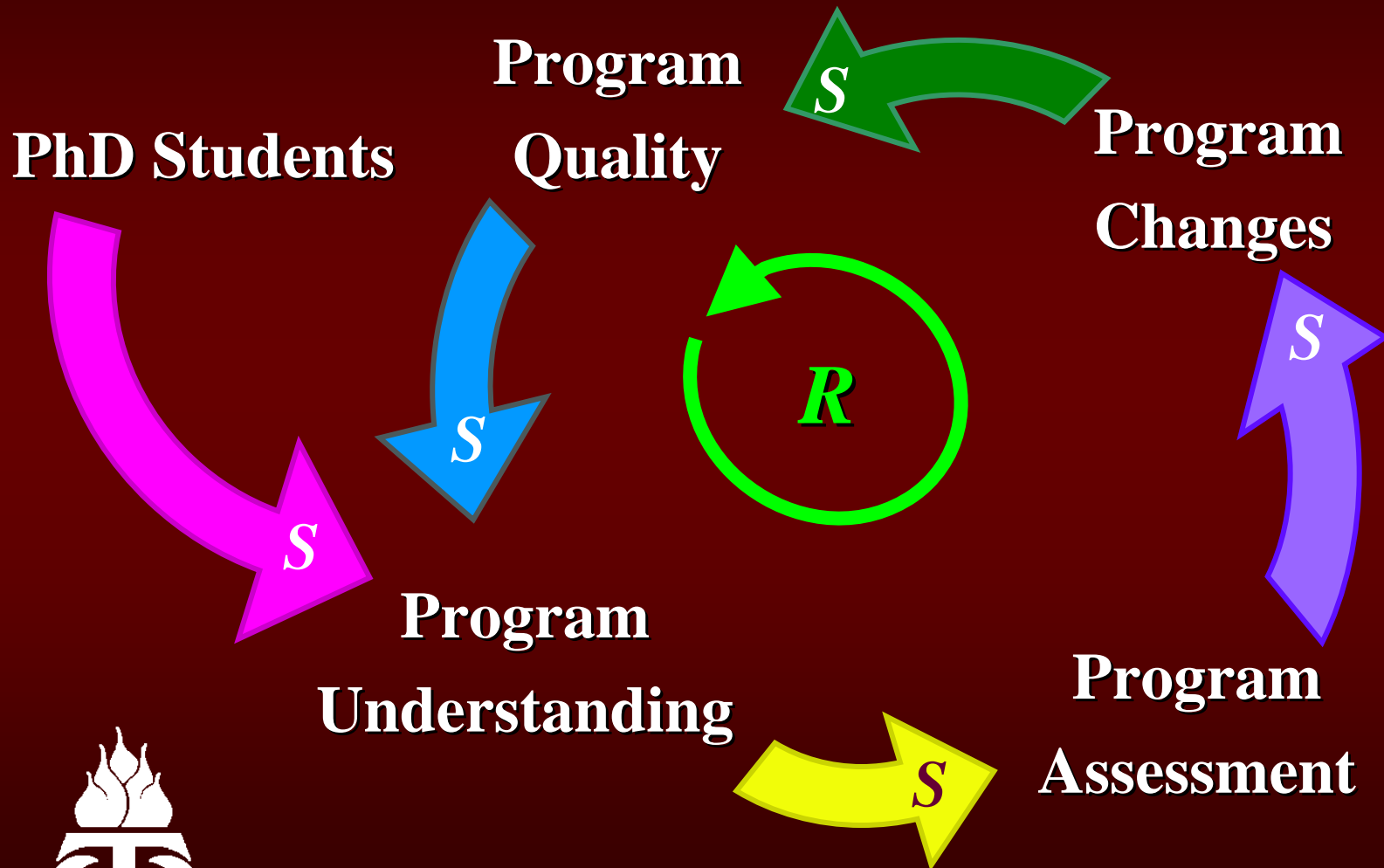


Lessons From a Student Project:

Systems Tools For Program Assessment



Understanding the Program

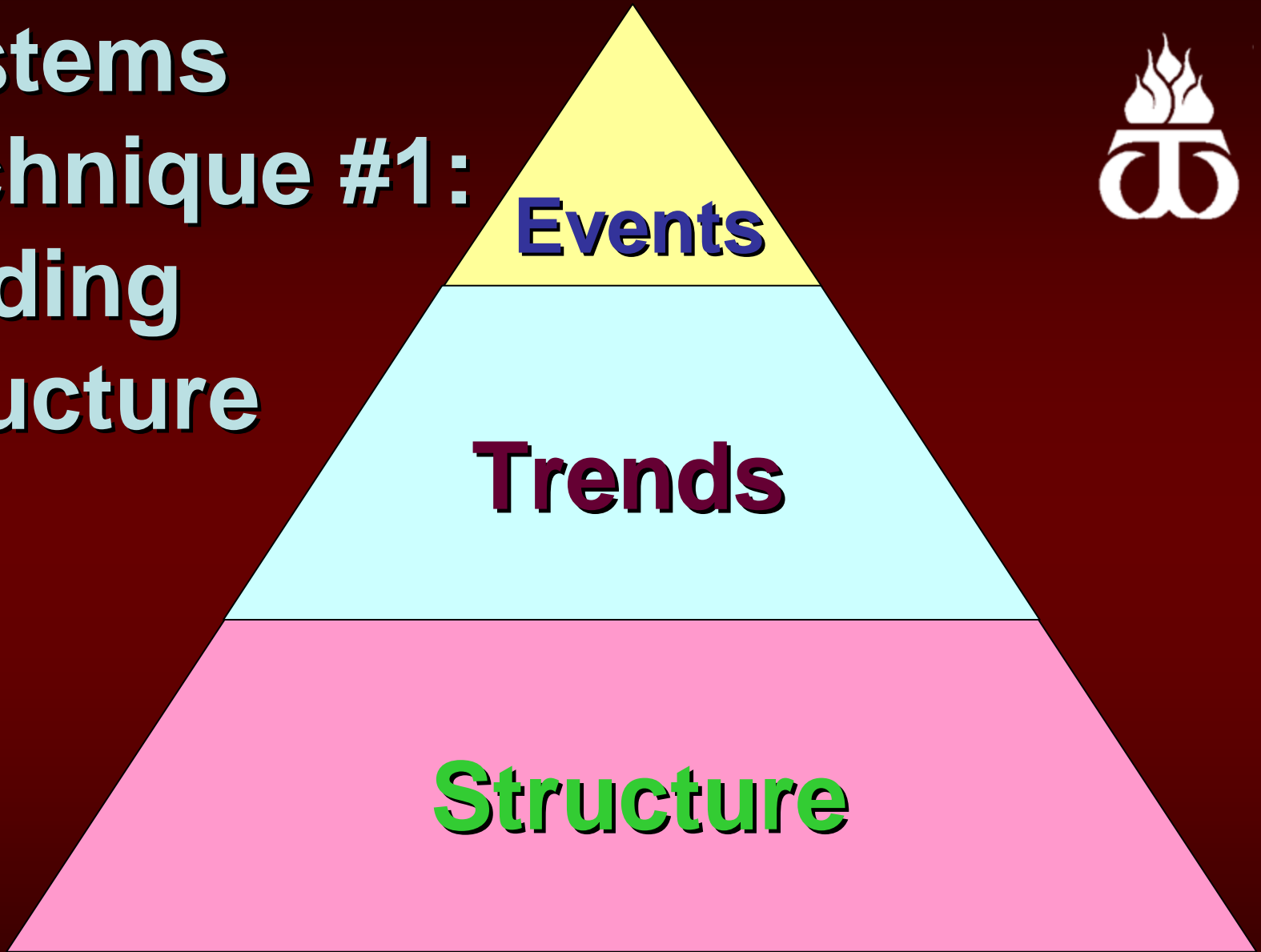


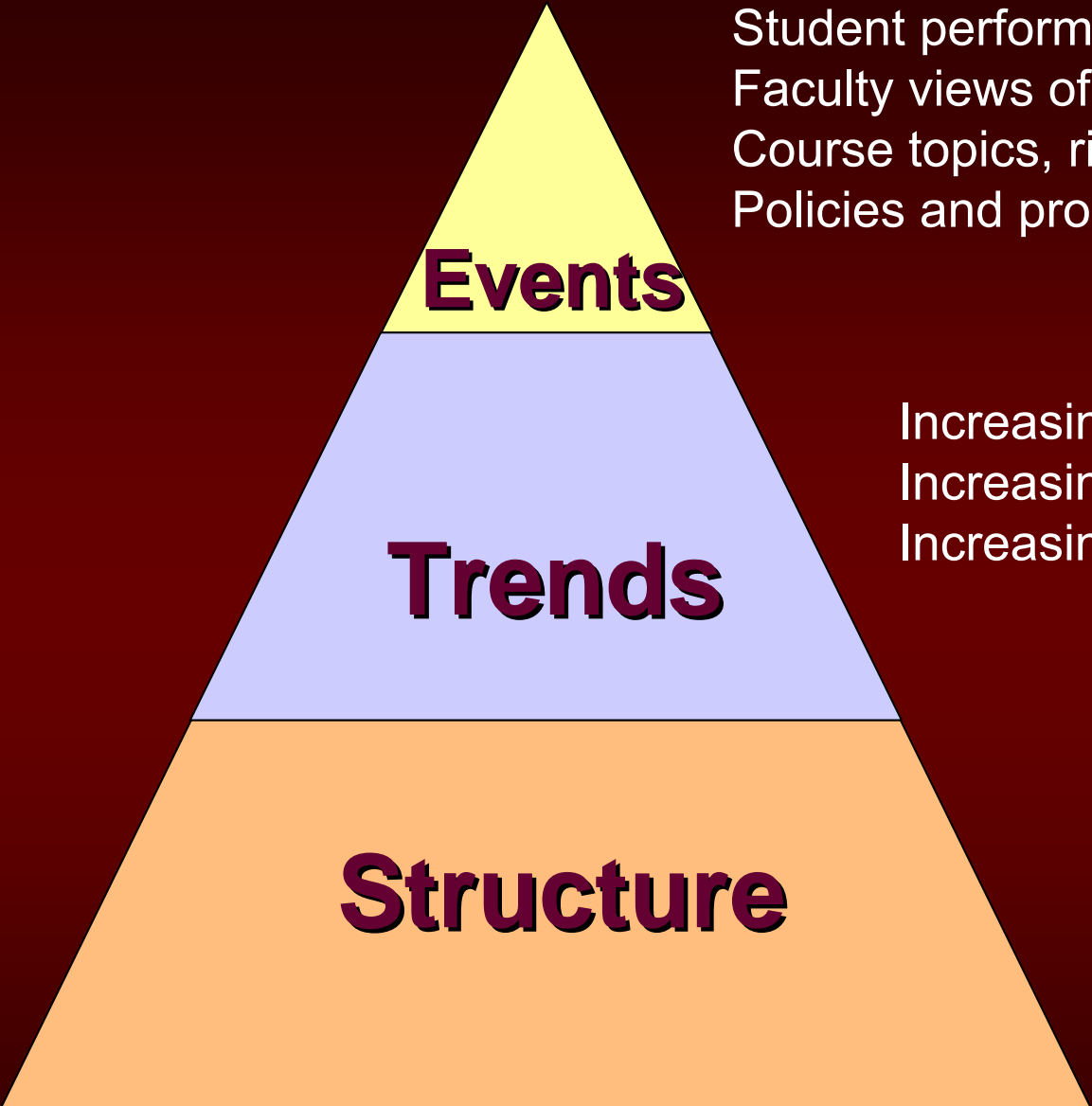
Systems Techniques for Program Assessment



- Focus on underlying, causative structure rather than program “events”
- Modeling to reveal “Mental Models” and identity leverage points
- *Assess Interactions*, not components

**Systems
Technique #1:
Finding
Structure**





Student performance
Faculty views of program
Course topics, rigor, and details
Policies and program execution

Events

Increasing confusion
Increasing focus on people
Increasing “Blame Game”

Trends

People were performing and acting reasonably. Department history, faculty background, and enabling document were driving trends and events.

Structure

The Importance of Leadership

- Systems Thinking is required in order to identify structure
- Leadership is a necessary part of Systems Thinking. (Senge)
- Leadership requires trust. (Covey)



Systems Technique # 2: Modeling

Models

- Iconic
- “Mental Models”
- Stock and Flow
- Mathematical

Purpose

- Understand
- Communicate
- Simulate



Program Purpose

- “...prepare *leaders* for the *agricultural* industry....
- trained in a *multidisciplinary, research-based curriculum*
- that emphasizes a *systems approach* to problem solving.”

**“My discipline already
does this. Students
will be trained in my
discipline just like I
was.”**

My discipline is complete,
we don't need others.



**“They will need multiple
Ph.D.’s, one for each
discipline.”**

We cannot do systems
work unless everyone
involved has a background
in everything.



“This sounds fine- as long as it does not dilute my discipline”

My discipline is most important and is what I want to do. We can add other components, but don't forget who is most important.

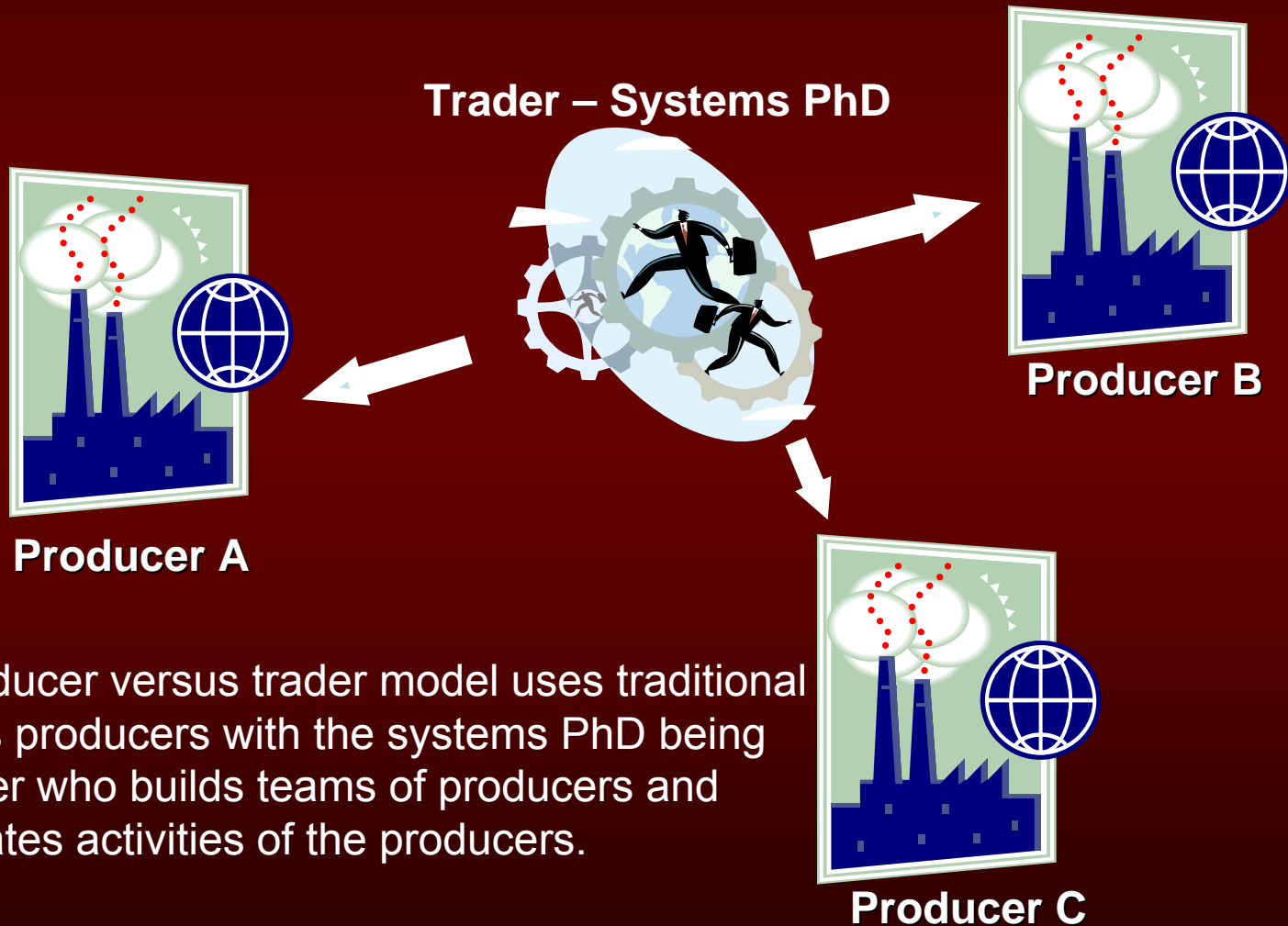


**“Wow, I get it!!!
My discipline is no longer
the main focus. . . this is a
completely new type of
program!”**

Holistic perspective recognizes that systems is a different approach. The individual disciplines are still important, but combining disciplines in a holistic manner provides more powerful results than additive impact of individual disciplines.



Producer vs Trader



The producer versus trader model uses traditional PhDs as producers with the systems PhD being the trader who builds teams of producers and coordinates activities of the producers.

Modified Systems Agriculture Model

- a, b, c = Discipline Treatments
- Graduate = a + b + c + e
- abc significant, $p < 0.05$
- If there is a significant interaction:
 - a, b, c are irrelevant individually,
 - and not additive,
 - regardless of p-value



Systems Technique # 3: Study Interactions



- A system, and the output from a system, is the result of complex interactions between system components.
- Identifying and understanding the interactions may be more important (and interesting) than focus on the components

System Interactions

- Student competencies (output) are the result of our PhD program (our system).
- The interactions between subject matter, rigor, and teaching methods contribute to our system output (student competency).

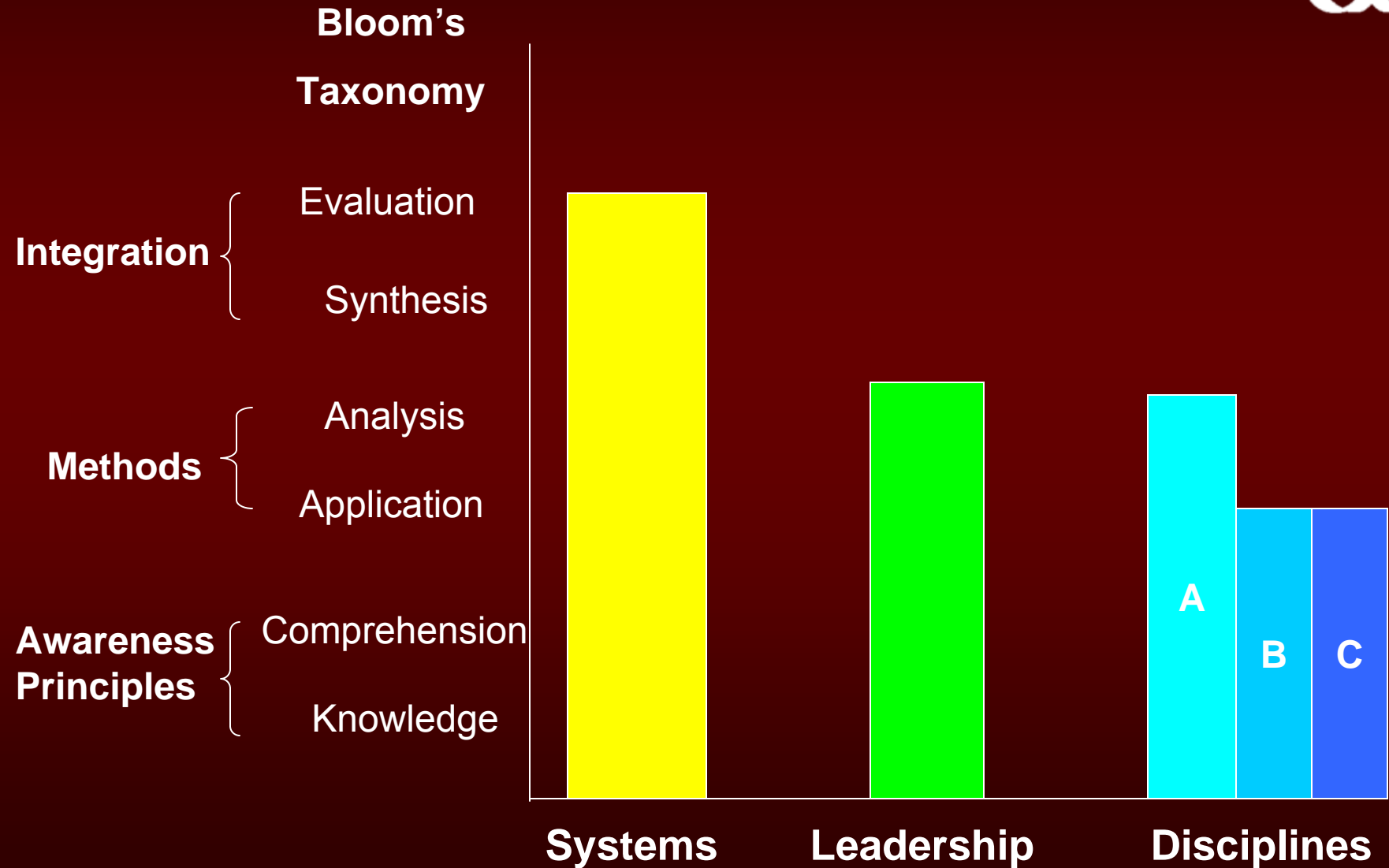


Potential Program Interactions

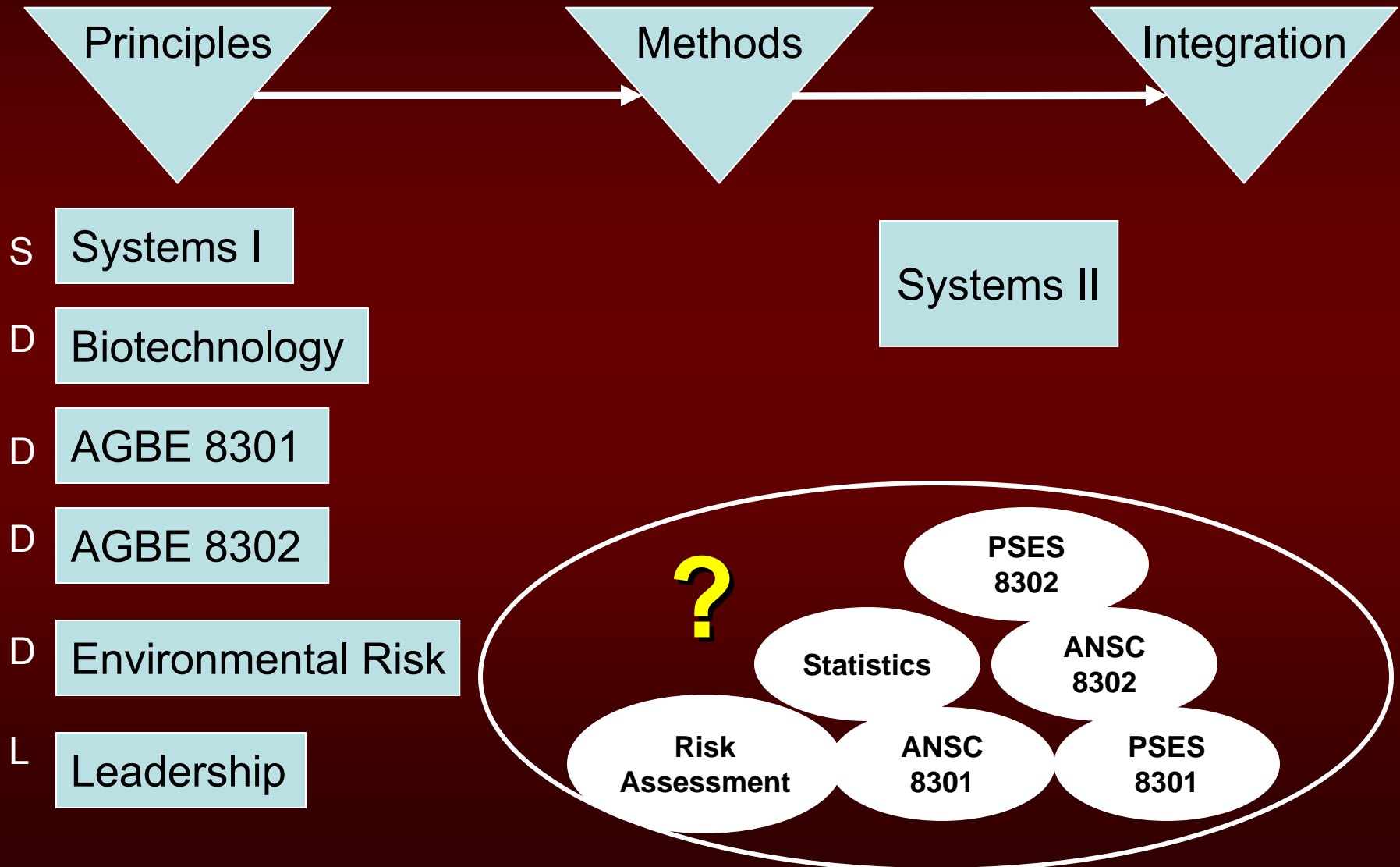
- Student ↔ Faculty
- Student ↔ Administration
- Student ↔ Student
- Discipline ↔ Discipline
- Subject ↔ Level
- Level ↔ Method
- Level ↔ Subject
- Level ↔ Subject x Method



Subject x Level



I can't explain it, but I know it is important!

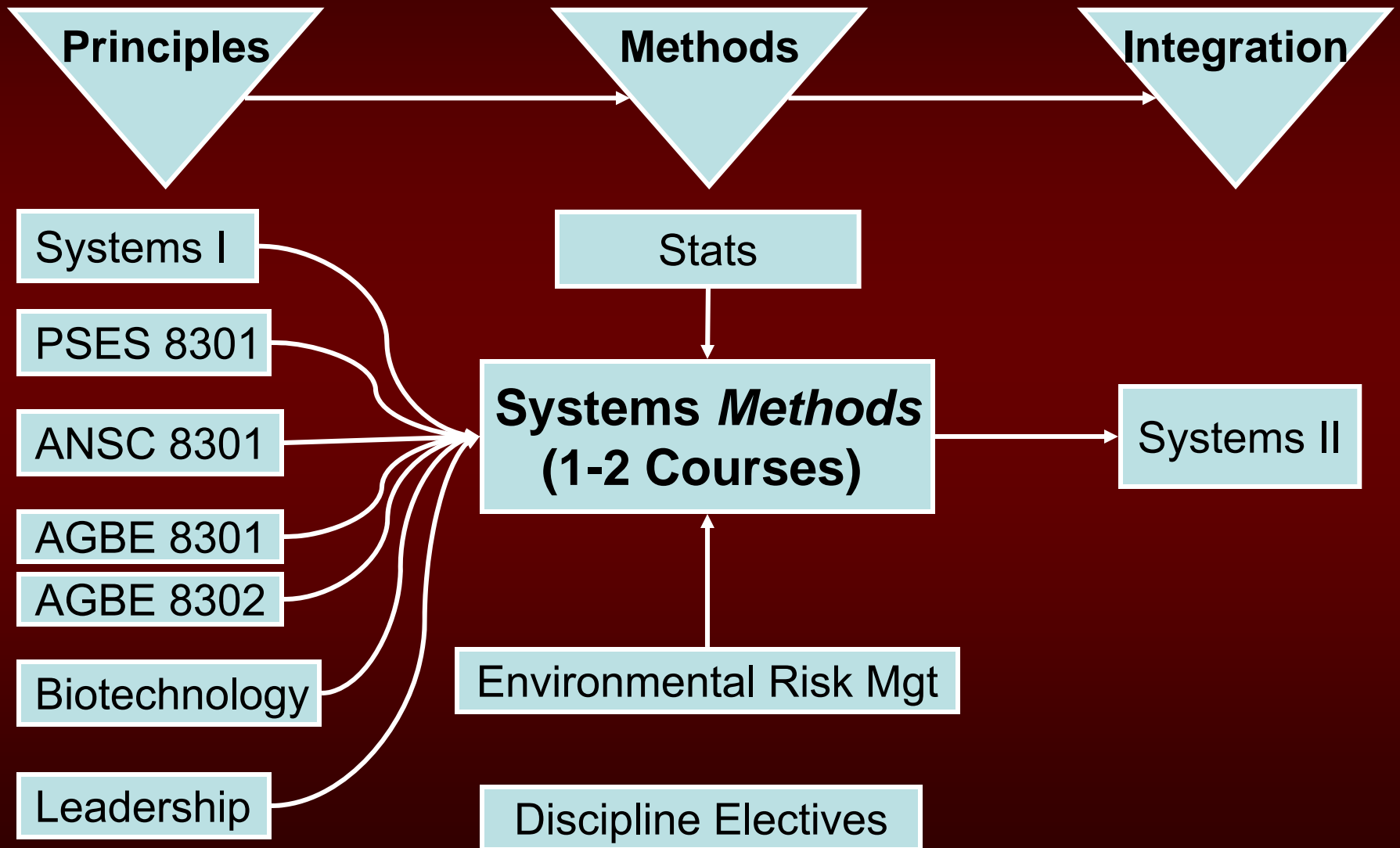




Proposal for Achieving Competencies

		Awareness	Methods	Integration
Curriculum	Systems	_____	_____	_____
	Leadership	_____		
	Disciplines	_____		
Research	Systems		_____	_____
	Leadership			
	Disciplines		_____	
Teaching	Systems			
	Leadership			
	Disciplines	_____		
Individual Study	Systems			_____
	Leadership			
	Disciplines		_____	

Study of interactions is productive.



Student Assessment:

Faculty Perspective

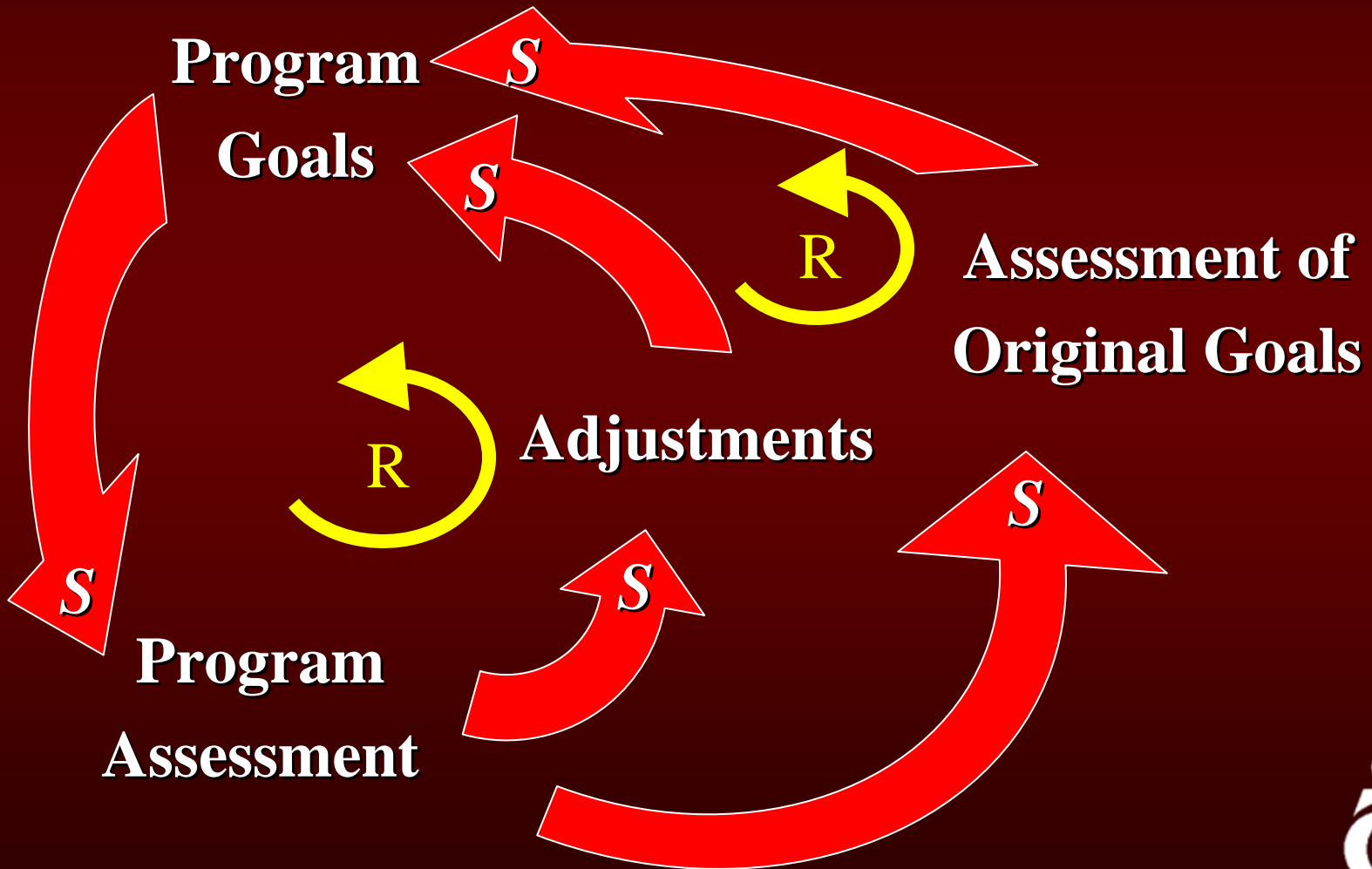




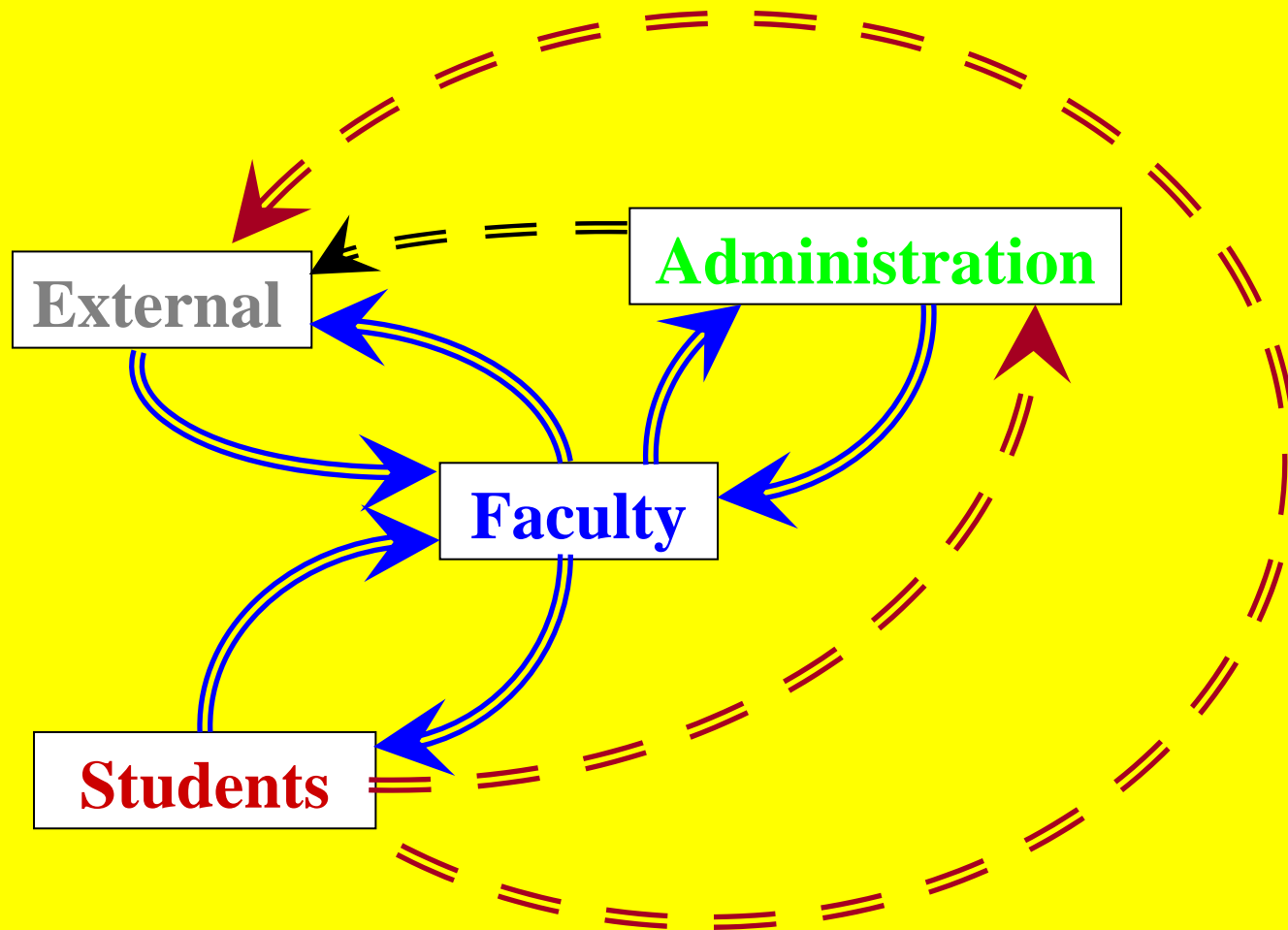
Proposal for Achieving Competencies

		Awareness	Methods	Integration
Curriculum	Systems	=====	=====	=====
	Leadership	=====	=====	=====
	Disciplines	=====	=====	=====
Research	Systems	=====	=====	=====
	Leadership	=====	=====	=====
	Disciplines	=====	=====	=====
Teaching	Systems	=====	=====	=====
	Leadership	=====	=====	=====
	Disciplines	=====	=====	=====
Individual Study	Systems	=====	=====	=====
	Leadership	=====	=====	=====
	Disciplines	=====	=====	=====

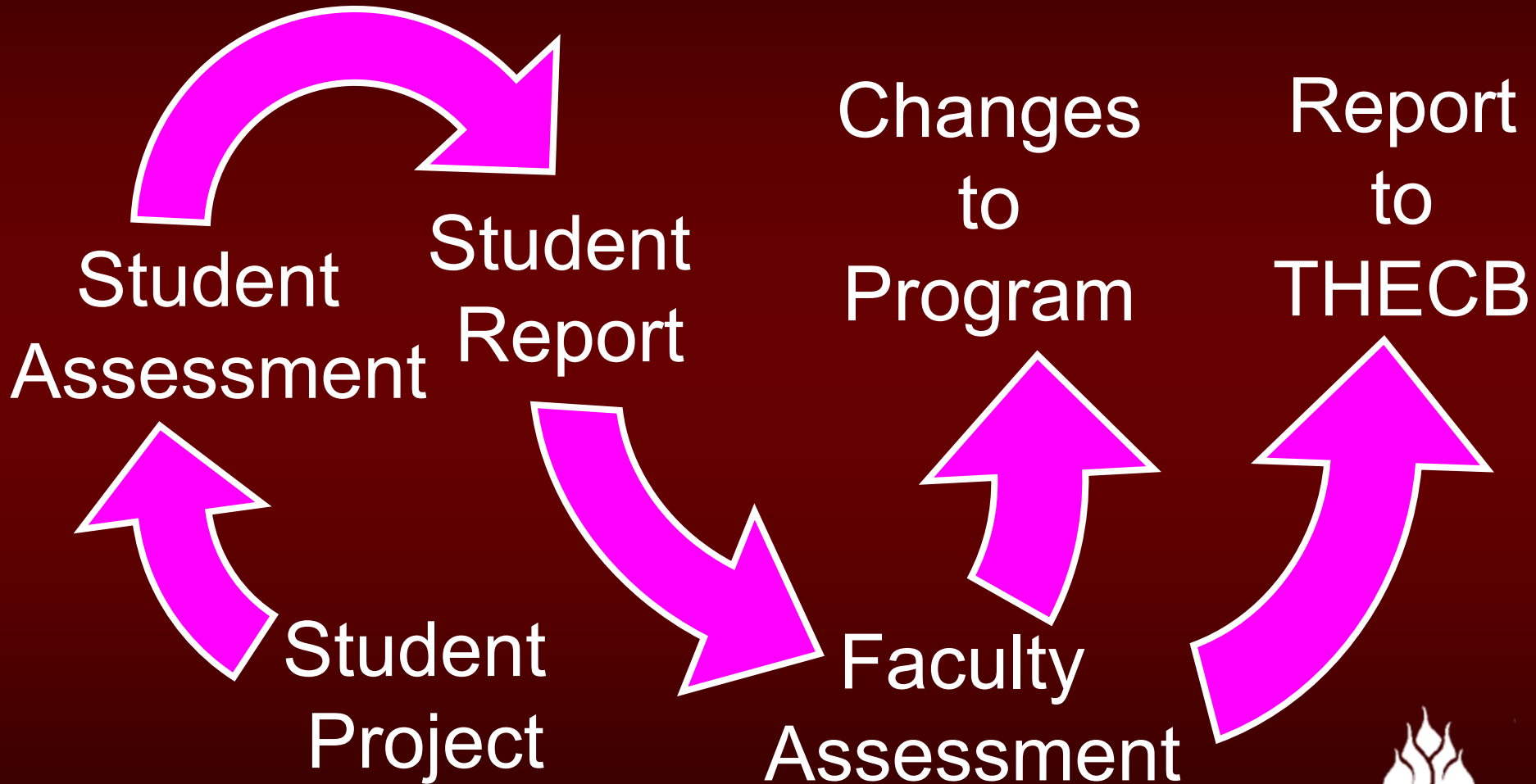
Using Systems Assessment



WTAMU PhD Assessment Interaction Diagram

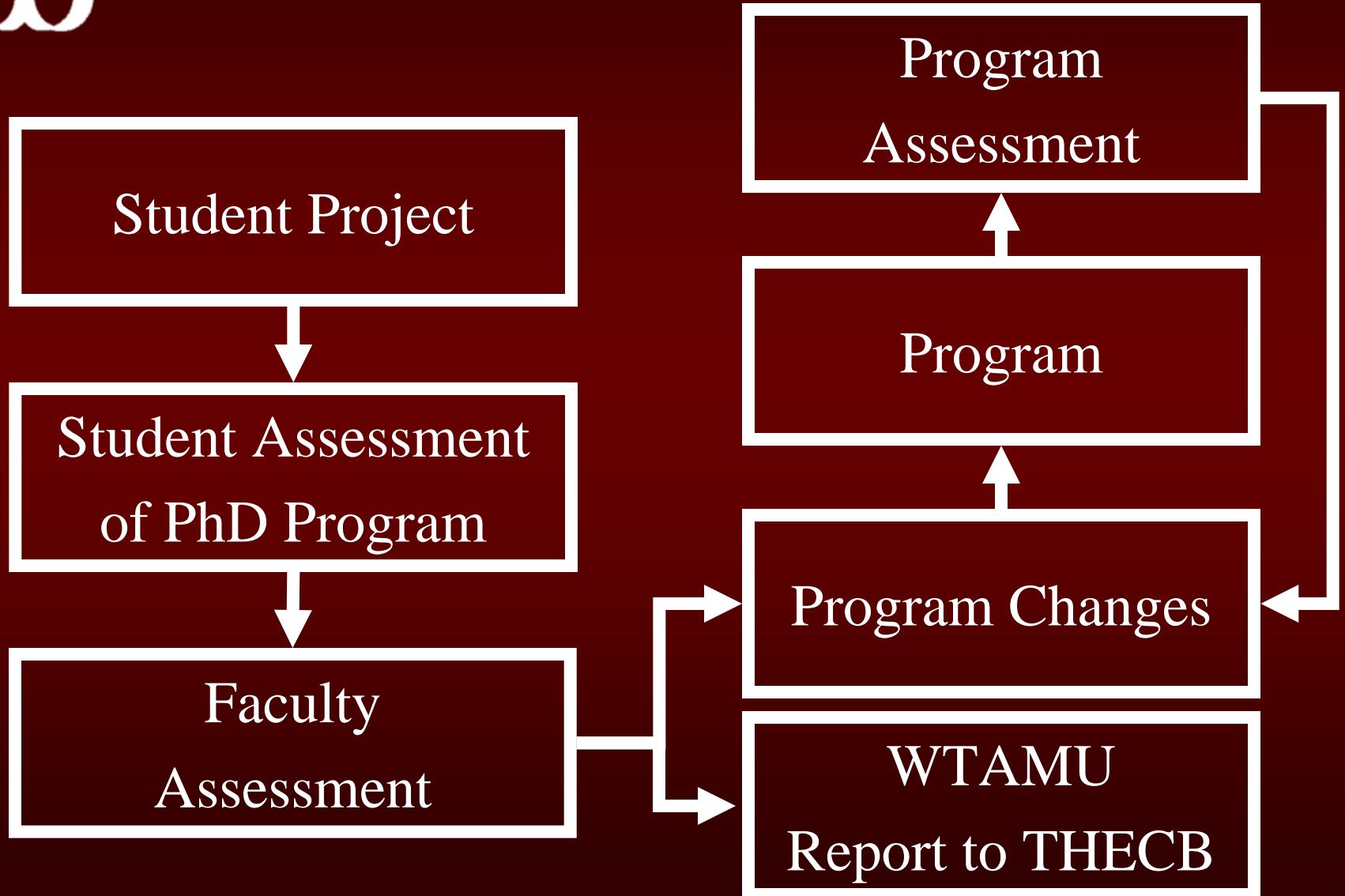


Assessment Results





Assessment Results



Where do we go from here?

- Review program proposal
 - Continuous review is important
 - Adjust for discrepancies
- Case Study – AGRI 8303
 - Review program analysis of previous students
- Revise courses
 - Address issues raised by students
- Continue program evaluation



Acknowledgements

PhD Students

Systems Agriculture II – Spring 2006

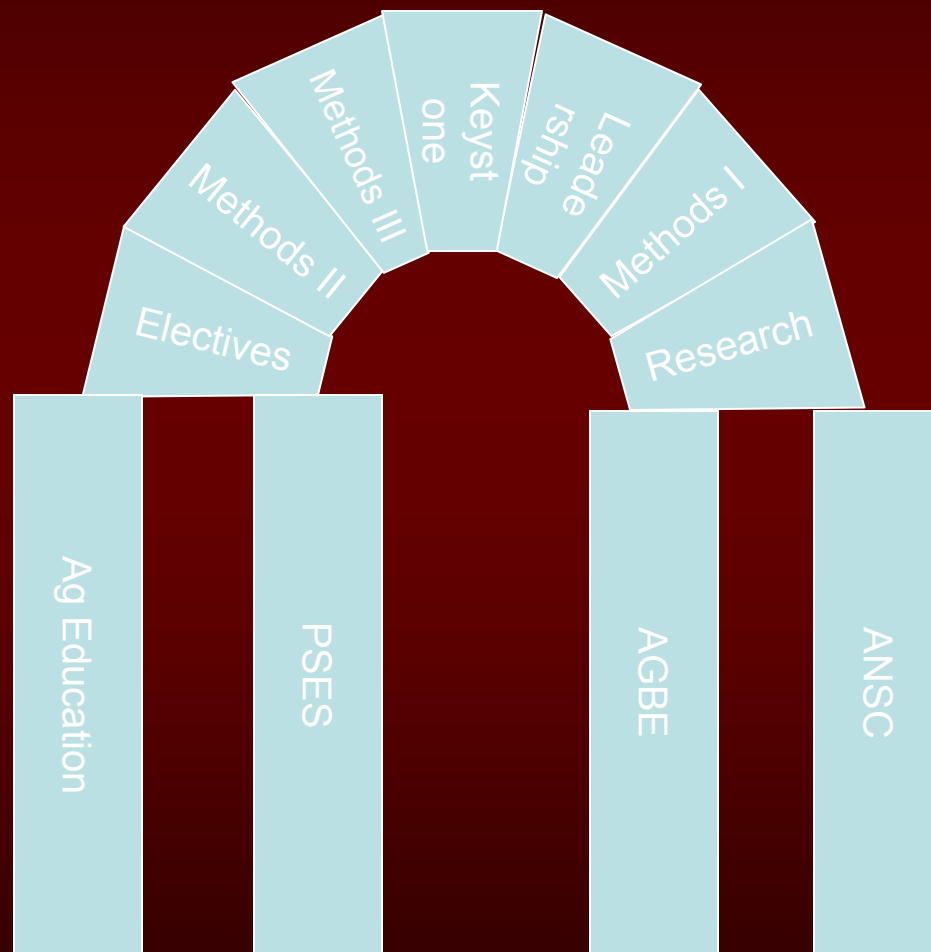
- Marty Rhoades
- Tebkew Belete
- Robert Herrington
- Robert Taylor
- Julio Silva

Additional Slides

More information is contained on
the following slides



A Systems PhD is Non-Linear



Traditional Single-Discipline Degree

- A = Single–Discipline Program Treatment
- e = error (variation in programs, reputation)
- Graduate = A + e
- B.S. degree = $P < 0.20$
- M.S. degree = $P < 0.10$
- **Ph.D. degree = $P < 0.05$**



Discipline-Plus Model

- A = primary discipline treatment
 - B = secondary discipline treatment
 - C = secondary discipline treatment
 - e = error
 - Graduate = A + b + c + e
-
- A – p < 0.05
 - B – p < whatever
 - C – p < whatever
 - AB, AC, ABC p < 0.1 = disaster!!!



Tri-Discipline Model

A, B, C = Discipline treatments

$$\text{Graduate} = A + B + C + e$$

Ph.D. Graduate	A	$p < 0.05$
	B	$p < 0.10$
	C	$p < 0.10$

AB, AC, BC, & ABC not significant



Traditional Systems Model

A = Systems Analysis Treatment

Graduate = A + e

A = p < 0.05

Available at DoD, Ivy League Schools, etc



**A Novel Ph.D. Program in Systems Agriculture:
Student Experiences in a Program Modeling Project
D. G. Lust, M.B. Rhoades, R. Taylor, J. Silva, T. Belete, R. Herrington**

Abstract

The six Ph.D. students enrolled in AGRI 8303 during the Spring, 2006 semester began development of conceptual and iconic models of the WTAMU Ph.D. program. The choice to model the program was proposed for the following reasons: (1) Students have a vested interest in the success of the program, (2) Students have a desire to better understand the program they are in, (3) Students sought to develop a common vision of the program, and (4) Students sought experience modeling an actual system problem. Five conceptual models were proposed to describe different types of programs. These are the single-discipline (SD), the discipline-plus (DP), the tri-discipline (TD), the single-systems (SS), and the modified-agricultural-systems (MAS) models. It was determined that the WTAMU program was best fit by the MAS model. This model emphasizes the importance of individual discipline principles, but emphasizes interactions among the disciplines as outweighing individual disciplines. The program was assessed to be focused on developing three distinct areas of competence: (1) Systems, (2) Leadership, and (3) Disciplines. Each area of competence has three competence levels. These are from lowest to highest: (1) Awareness, (2) Methodology, and (3) Integration. Graduates of this program should have the highest competence levels in Systems, with Methodology levels in Leadership and Disciplines. Once the MAS model was more fully developed, it became apparent that the current program offered few activities focused on systems methodology. Systems Methodology is viewed as a prerequisite to integration. It is proposed that the program be adjusted to strengthen foundations in discipline principles and systems methodology required for solving systems problems. Challenges in teaching students with varied backgrounds were addressed by proposing a restructuring of discipline courses to focus on the fundamental principles of the discipline. Students with an M.S. in their primary discipline would not ordinarily need to repeat instruction in that discipline. Future work to more fully complete the program model may include a focus on interactions between courses, disciplines, or research components.

Introduction

The Ph.D. degree originally (12th century) implied a great breadth of learning. “Doctor” is Latin for “teacher,” and early Ph.D.’s were expected to be proficient in diverse topics, including grammar, language, rhetoric, logic, math, astronomy, music, art, and science. By the mid to late 1800’s, American Ph.D. programs were more specialized. This specialization had its origins in the German universities (Fichte, 1810; cited by Winkler, 2001). The German acceptance of research and science as the only basis for the title of doctorate was firmly established by 1895-96 when 517 Americans officially matriculated at German institutions. Secularization and standardization of the degree continued until by 1940 the term “Ph.D.” acquired the standard meaning of great specialization, rather than breadth. This is the modern understanding of the Ph.D. in the United States. The advent of the Doctor of Philosophy is a sign of the modern era, symbolizing the 19th century professionalism of the arts and sciences.

Specialization has its critics, however, and some have alleged an inability of modern Ph.D.'s to think, act, or function outside of their narrow discipline, when many problems are broad and multi-disciplinary in nature. Modern revisionists have renewed the focus on broadening the Ph.D. degree in recent years (Nyquist and Woodford, 2000).

Agriculture is particularly multi-disciplinary in nature, because many of agriculture's greatest challenges involve aspects of plant science, soil science, environmental science, animal science, biology, economics, and social science. Some in the agriculture industry have identified a need for more broadly trained graduates who can understand and communicate technical and research-based issues, but who are comfortable communicating and working across multiple disciplines. This realization contributed to West Texas A&M University's choice to adopt a multi-disciplinary approach for its maiden Ph.D. program in agriculture. The program began in September, 2003. Enabling documents characterize the program as "a systems approach to the solution of agricultural problems".

The development of the WTAMU multidisciplinary Ph.D. program was driven by a variety of ideological, financial, logistical, political, administrative, and other forces, including time constraints. The current program is therefore not necessarily a product of any one commonly understood model. Elements of various models, of varying specificity, no doubt have contributed and continue to contribute to the program.

The objectives of this project were to identify and review models related to different program perspectives, to propose models that facilitate a common program perspective, and to stimulate discussion related to program management.

Methods

Six Ph.D. students enrolled in AGRI 8303 (Systems II) began development of conceptual and iconic models of the WTAMU Ph.D. program during the Spring 2006 semester. AGRI 8303 is designed as a systems capstone course where Ph.D. students are expected to apply systems concepts during the completion of a class modeling project. Students presented project proposals to instructors for approval. Instructors consisted of three faculty members involved directly in development, teaching, and administration of the WTAMU Ph.D. program, and represented multiple and diverse disciplines. Instructors included the Ph.D. Program Coordinator and the Division Head. The choice to model the program as a project activity was proposed by students for the following reasons:

1. Students have a vested interest in the success of the program.
2. Students have a desire to better understand the program they are in.
3. Students sought to develop a common vision of the program.
4. Students sought experience modeling an actual system problem.

Review of the WTAMU program formation documents, student experiences in the program, and discussion were used as project methods. Students reviewed relevant literature related to systems principles, and sought to apply concepts to the modeling process. In addition, review

of literature related to agricultural systems educational models was conducted. Various concepts from multiple disciplines were applied to the program model. In particular, effort was made to identify, develop, and communicate different models of how program objectives might be viewed by faculty, students, and other stakeholders. Once developed, several prospective models were evaluated. One of these models was proposed as most appropriate for the program's intent, and was further developed and considered. Several mental models were developed to communicate the key points of the proposed program model. The current (2003 to present) program management was evaluated within the framework of the proposed program model, and management recommendations were proposed.

Students made two presentations of project results to faculty, students, and guests during the weekly spring departmental seminar. This paper served as the final report of the project. Finally, each student developed a written report summarizing individual observations and evaluation of the project activities.

Results

Students assessed the process required for complete modeling of the program. Bawden et al., 1984 proposed a "Soft Systems Approach" to modeling which focused on situation improvement as a goal. Terminology from Bawden's modeling procedure was employed. Students proposed that this modeling project is focused on "expression of the problem situation", "identifying the transforming system", "modeling the transforming system", and "comparing the model with reality." (Bawden, 1984).

It was apparent that the WTAMU Ph.D. program was intended to consist of some combination of discipline principles (from multiple disciplines) and "systems" principles and applications. Students proposed five general conceptual models to describe and communicate alternative student and faculty perspectives of program objectives. It was observed that such perspectives likely do exist among program stakeholders. Conceptual models proposed include the Single Discipline (SD), Discipline-Plus (DP), Tri-Discipline (TD), Single Systems (SS), and Modified Agriculture Systems (MAS) models. These models use a traditional statistical design of treatments and results as a metaphor for program emphases and graduates. Outputs are tested for significance via 'p-value' (i.e. significance is achieved at $p < 0.05$). Students receive various program "treatments" and the graduate is the result. Significance is then tested. The five conceptual models of how program objectives might be perceived are presented below.

Single Discipline Model

The SD model assumes the current approach to most Ph.D. programs. Students major in a single discipline from the time they enter an institution of higher education. In this scenario, a single discipline, A, is studied throughout the collegiate career. This individual is very competent in that discipline. Expectations for other disciplines are minimal or unspecified.

A = Single Discipline graduate program treatment

ϵ = error (variation in programs, students, reputation, etc)

$$\text{Graduate} = A + \varepsilon$$

B.S. degree significance - $p < 0.20$

M.S. degree significance - $p < 0.10$

Ph.D. degree significance - $p < 0.05$

The individual completing the requirements to obtain a doctorate under the SD model is considered to be highly significant in that discipline. They are significantly more knowledgeable than others concerning that discipline.

Discipline-Plus Model

The DP model is a variation of the SD model in that there is still one primary discipline treatment, but the students are exposed to secondary disciplines in the program. The student is still expected to achieve a Ph.D. level of significance in the primary discipline, along with some familiarity of secondary disciplines. Under this model, significance in the secondary disciplines is variable, but less than in the primary discipline. Interactions among the discipline treatments are not desirable, as they affect (lessen) the significance of the primary discipline.

A = primary discipline treatment

β = secondary discipline treatment

χ = secondary discipline treatment

ε = error

$$\text{Graduate} = A + \beta + \chi + \varepsilon$$

Graduate significance:

A	=	$p < 0.05$
β	=	$p > 0.20$ or unspecified
χ	=	$p > 0.20$ or unspecified

$A\beta$, $\beta\chi$, $A\chi$, $A\beta\chi$ interactions not significant

Tri-Discipline Model

The TD model attempts to correct what could be seen as a failing of the DP model, that being the lessened significance of secondary discipline treatments. The TD model requires a more rigorous exposure to the secondary disciplines. The prospective graduate of this program would still gain a Ph.D. level of significance in their primary discipline, and would gain an M.S. or similar level of significance in the secondary disciplines. The graduate of this type of program would in effect have three reductionist degrees, with no interactions among the degrees. This model still emphasizes additivity, not interaction.

A, B, X = Discipline treatments

$$\text{Graduate} = A + B + X + \varepsilon$$

$\alpha\beta\chi$ significant, $p < 0.05$

If there is a significant interaction, α , β , χ are not individually significant, and not additive, regardless of p-value.

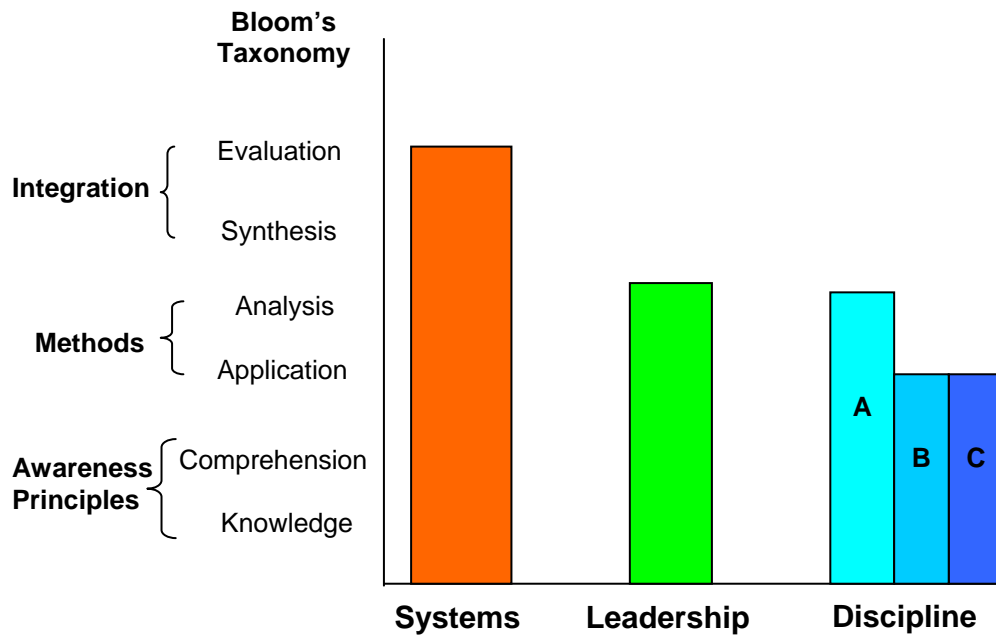
Several iconic models were also developed to further clarify the focus of the Modified Agriculture Systems Model. All communicate the emphasis on interaction between disciplines, rather than on the disciplines themselves. Two models proposed focus on Pillars and Arches, and on Producers and Traders.

The Pillar-Arch model describes discipline principles as vertical, pillars of knowledge that are built to various heights, but that do not connect. Arches connecting the pillars are non-linear, and represent the systems methodology that might be used to connect disciplines. Students proposed that the program should focus on arches (interactions) primarily, and discipline pillars secondarily, while recognizing the importance of the discipline pillars in supporting the systems arches.

The Producer-Trader model proposes that traditional single discipline Ph.D. graduates function as producers of discipline science. They produce grants, research results, research publications, teaching materials and other discipline science products. Students proposed that the graduates of the WTAMU program under the MAS model might function more as traders who are familiar with discipline products and production techniques, but who engage primarily as facilitators of trade between disciplines. They determine what discipline products are valuable to other disciplines, and foster communication and trade of ideas and discipline science products. Such trade requires expertise in the use of systems methods to facilitate the details of mutually beneficial interaction between disciplines. Production of discipline science is a secondary role.

Organizational, Flow, and Feedback Models. Once the MAS program model was developed and proposed, determining a framework or organizational structure for evaluating the program was necessary before more specific or management oriented models could be proposed. The WTAMU Ph.D. program was characterized as focused on producing three distinct graduate competence areas (CA). These three areas were designated as Systems, Leadership, and Disciplines. Three competence levels (CL) for each area were also proposed. CL include Awareness/Principles, Methodology, and Integration. Competence levels were designated as the DJRRMT Taxonomy. They were adapted from Bloom's Taxonomy and simplified for expedience. Students proposed that the program should produce the highest CL in Systems, with lower levels in Leadership and Disciplines. It was recognized that most students would have higher CL in the discipline in which they held the M.S. degree. While the MAS program model emphasizes the Systems CA, the reduction in primary discipline CL could remain minimal. Proposed program CA and CL are summarized in Figure 1.

Figure 1. Competence Areas and Competence Levels for WTAMU Ph.D. Graduates



The organizational framework for evaluating program content and program management was further developed via identification of methods that might be used to develop the proposed CL for each CA. Students proposed four primary means for developing competencies. Students propose to gain competencies by matriculation through the curriculum (taking courses), by conducting research, by teaching, and through other individually initiated study activities. A summary of the proposed methods and CA is presented in Table 1.

Table 1. Methods for Achieving Competency Levels

		Awareness/Principles	Methodology	Integration
Curriculum	Learning Methods			
Research				
Teaching				
Individual Study				

Students assessed curriculum and research components of the current program and proposed modifications based on fitting the program to the MAS program model. Assessments and proposals are presented in the following tables. Student assessment of program CA, CL and Learning Methods is presented in Table 2.

Table 2. Current Status of Program Competency Areas (CA), Competency Levels (CL), and Learning Methods

	Competency Area	Competency Levels		
		Awareness	Methodology	Integration
Curriculum	Systems	✓		✓?
	Leadership	✓		
	Disciplines	✓		
Research	Systems		?	?
	Leadership			
	Disciplines	✓?	?	
Teaching	Systems			
	Leadership			
	Disciplines			
Individual Study	Systems	✓	✓	
	Leadership	✓		
	Disciplines	✓	?	

Students noted a dearth of activity with the objective of helping students reach the Methodology CL. Methodology was proposed as a necessary step for attaining the Integration CL. Structured teaching is not currently employed as a learning method.

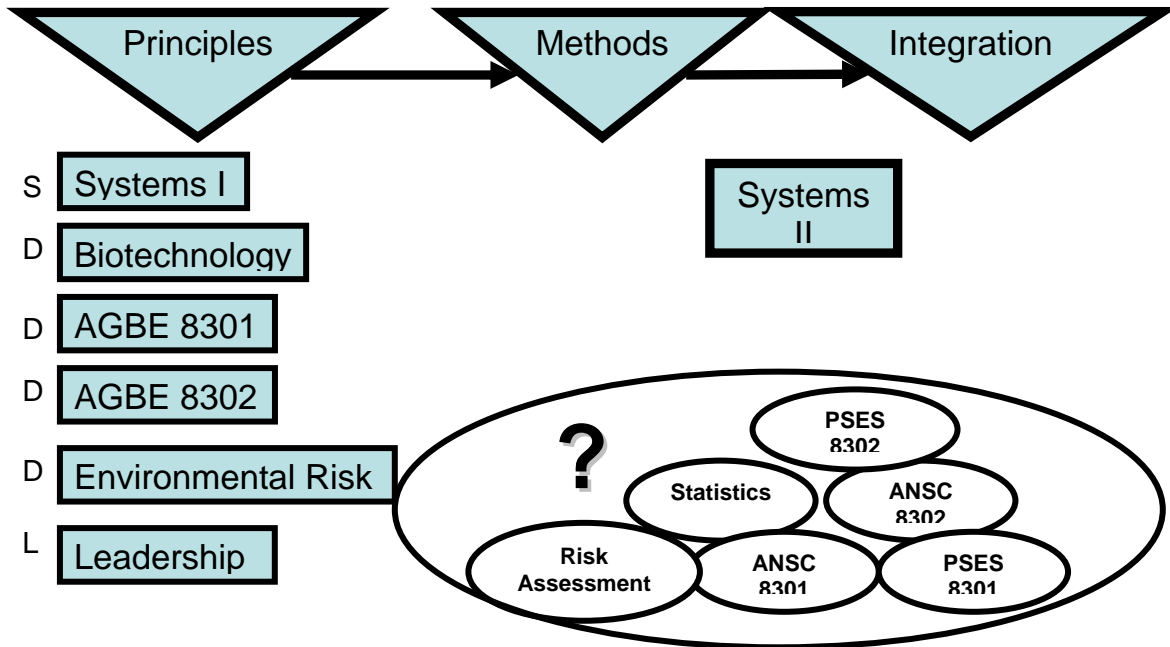
Student proposal for program CA, CL and Learning Methods is presented in Table 3.

Table 3. Proposed Program CA, CL and Learning Methods

Learning Method	Competency Areas	Competency Levels		
		Awareness	Methods	Integration
Curriculum	Systems	✓	✓	✓
	Leadership	✓		
	Disciplines	✓		
Research	Systems		✓	✓
	Leadership			
	Disciplines		✓	
Teaching	Systems			
	Leadership			
	Disciplines	✓		
Individual Study	Systems			✓
	Leadership		✓	
	Disciplines			

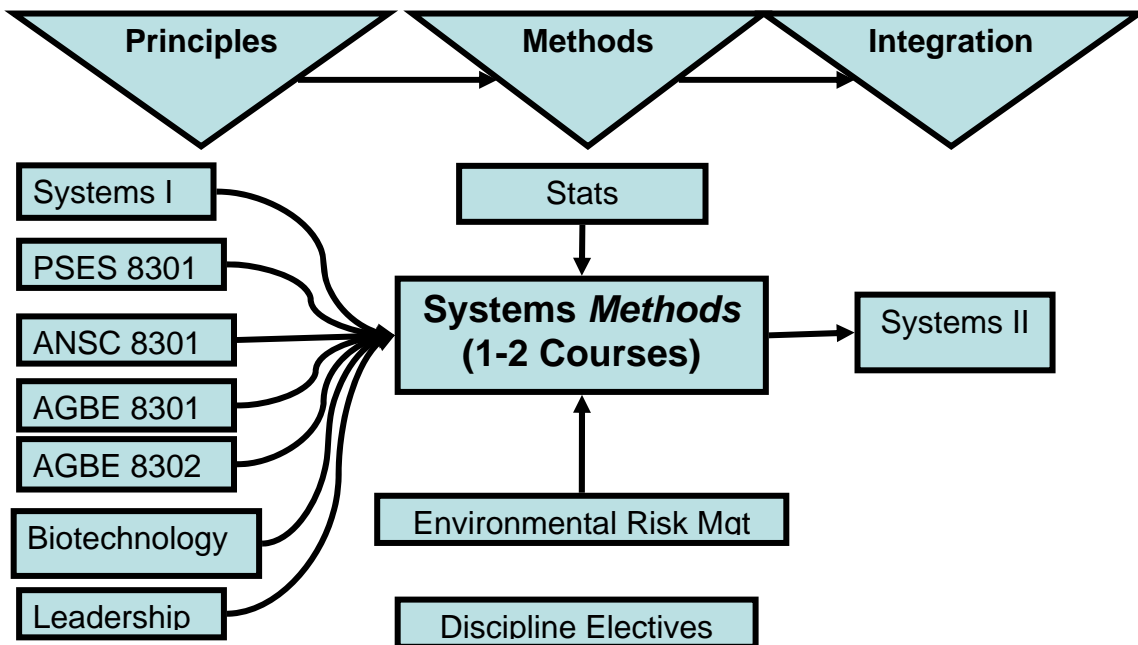
Student assessment of Curriculum Flow and Function is presented in Figure 2.

Figure 2. Student Assessment of Curriculum Flow and Function



Student proposal for Curriculum Flow and Function is presented in Figure 3.

Figure 3. Student Proposal for Curriculum Flow and Function



Discussion

The Systems component of the program reflects the emphasis on understanding interactions between multiple agricultural disciplines, and a conscious decision to move away from the reductionist approach to the Ph.D. Leadership was a component stressed in program formation documents, and required as a component by outside reviewers during program formation. A focus on discipline knowledge reflects the fact that the department offers B.S. and M.S. degrees in Agricultural Business and Economics, Animal Science, and Plant, Soil, and Environmental Science, and that a decision was made during program formation to have a multidisciplinary program. Faculty are traditionally trained in their respective disciplines.

Proper modeling requires a problem to be solved or improved. In addition, models serve various purposes: they may clarify, identify, illustrate or communicate problem situations, they may serve to evaluate processes, or may provide optimal solutions to problems. Modeling must begin with a situation objective as a prerequisite to the actual model development. For these reasons, considerable effort was focused on identifying and communicating WTAMU Ph.D. program objectives prior to development of detailed models that might be useful for program management or optimization.

The five conceptual models proposed were evaluated by considering how each might contribute to the competitive advantage of WTAMU and its Ph.D. graduates. They were developed with the intent of considering and communicating some alternative program objectives. The five models are not presumed to be an exhaustive list; it was recognized that additional models could be proposed. Many Ph.D. programs, including WTAMU's, are likely to exhibit elements of more than one of the models.

The SD model offers little advantage to WTAMU aside from its familiarity and widespread recognition as a typical Ph.D. WTAMU is a small school with a new program, and no history or Ph.D. program reputation. At best, a SD model would produce graduates that must compete against the superior perception established by land grant schools, even if technical competence were similar or superior. Practically, WTAMU is not well positioned to offer SD Ph.D. programs in multiple disciplines.

The DP program model offers the advantage of attempting to include multiple disciplines, yet still allows students to progress in their primary discipline. However, a key question pertaining to this model is in assessing the value of the secondary disciplines in contrast to their cost. As proposed in the SD model, it is questionable that the secondary disciplines will add more value than cost. Students perceived that dilution of, or distraction from, the primary discipline is a key (and understandable) concern among faculty – that is, faculty fear that primary discipline significance will be sacrificed for superficial training in secondary disciplines. Students are understandably concerned that a DP program model will simply result in a program of traditional primary discipline length and rigor, with the further requirement of secondary discipline training. Both SD and DP program models value discipline competence, without fully accepting the value of multidisciplinary or systems models.

The TD program model values multidisciplinary training. It attempts to resolve the dilution and distraction problem of the DP model by insisting on high levels of significance in multiple disciplines. In this respect, it views discipline treatments as additive. A review of the current curriculum revealed that elements of this model were likely employed during curriculum development. The result of a TD program model would likely be graduates with encyclopedic breadth and depth of knowledge. The TD model still fails to address interactions between disciplines however, except via the misconception that additive discipline treatments amount to “the systems approach”. The TD model also bears the practical disadvantage of presumably requiring significantly more time to complete than the traditional Ph.D. Time to degree is already a topic of concern related to the Ph.D. Unless an undiscovered method of training can result in three degrees in the time currently allotted for one, the TD model is likely to be rejected by students and administrative oversight units.

The SS program model offers the advantage of rigorous training in Systems Analysis or a synonymous discipline. In practice, such a model is administered in the traditional SD way. The SS model would likely produce graduates capable of applying systems principles and methodology to agricultural problems in multiple disciplines. These advantages are outweighed in the WTAMU program by the poor practical fit, since the SS model would require a program and faculty thoroughly trained and steeped in Systems Analysis. The SS model does not necessarily pertain at all to agriculture. The WTAMU faculty and students are not likely to abandon agriculture, nor is it likely that an entire Agriculture program and faculty would be replaced to pursue Systems Analysis *per se*.

The MAS program model bears the burden of being the most novel, and is at risk of rejection simply due to unfamiliarity. However, it provides a competitive advantage to WTAMU in that it could produce uniquely trained graduates. Further, it retains fewer practical obstacles to success than other models. The MAS model does require a commitment to developing expertise in agriculture systems principles and methods. It also requires that Systems competencies be achieved, measured, recognized, and valued. It is the single model that may function within the existing situation to produce a competitive advantage in a reasonable time.

Project students chose the MAS model, enhanced by the Producer-Trader iconic model, as the models that best describe the intended and desirable objectives of the WTAMU program. Subsequent modeling efforts did not pertain to the other program objective models. Curriculum and research flows were evaluated, and corresponding proposals for improvement were developed within the context of how they fit the MAS objective model. No consideration was given to determining how flows matched other program objective models.

The evaluation framework of three competence areas (CA: Systems, Leadership, Disciplines), three competence levels (CL: Awareness, Methods, Integration) and four Learning Methods (Curriculum, Teaching, Research, Individual Study) was developed and proposed as a way to organize the task of determining how the MAS program objective model might be achieved. Other organizational frameworks could be developed and might prove equally useful. Certainly, it is expected that increasing levels of detail and specificity will be necessary as program modeling and feedback continues.

Several key question areas related to the Modified Agricultural Systems (MAS) model were discovered during the evaluation portion of the project. These are:

- What are the specific Systems competencies that are necessary for the Modified Agricultural Systems program graduate? How are they achieved and measured, and how is their value communicated?
- What levels of Discipline “treatments” are required in the MAS model, and how are they taught and achieved, particularly in classrooms where students arrive with distinctly different discipline backgrounds?
- What are the specifics of the leadership competence areas?
- What is MAS research?

Evaluation of the Curriculum as related to the Systems CA revealed that the current program is focused on addressing the Awareness CL. A single course (AGRI 8303 Systems II) is described as addressing the Integration CL for Systems. However, courses are noticeably absent in the Methodology CL. Therefore it is doubtful that AGRI 8303 will successfully transmit to students the Integration CL in Systems, since students have not likely mastered the Methodology CL. Thus the proposal calls for development of curriculum specifically designed to teach the techniques and methods necessary to perform agriculture systems analysis and management. Students concluded that specific systems methods are available, and such methods entail significantly more than awareness of systems definitions and principles, and require more than a “systems attitude” or vague “systems approach” as proof of mastery. Competence can be confirmed by the student’s ability to perform multidisciplinary agriculture systems analysis using established techniques. It is proposed that the value of this competence, once demonstrated, will be apparent. In summary, a key proposal is that the MAS model must emphasize the Systems competency areas as a priority.

What depth of Discipline knowledge is required in the MAS program model, and how should it be achieved? A major challenge for a multidisciplinary Ph.D. program is balancing breadth and depth in the classroom. Since applicants are accepted with a M.S. degree in any one of the three primary disciplines, few are likely to have the typical preparation in the other disciplines. If the disciplines are equally represented among the students, this means that a faculty member teaching a discipline oriented course can expect two thirds of the students to be unprepared for graduate level work in his discipline. For example, a Ph.D. level course in economics would traditionally expect students to have a strong math background, including calculus. In this program, two thirds of the students might have M.S. degrees in animal or plant science, and little economics or calculus background. A course in animal or plant science might expect proficiency in biochemistry, which the students with agricultural economics or education backgrounds would not have. This fundamental issue, termed the “Classroom Dilemma”, is presented to each faculty member teaching a course in the multidisciplinary program.

Students propose to resolve the Classroom Dilemma by adjusting the content of the current curriculum. Presently, the 8301 series (ANSC 8301, PSES 8301, AGBE 8301) has presented surveys of the disciplines, some review of discipline principles, and a focus on systems and leadership problems related to the discipline. All students are required to take these courses. The proposal is to refocus these courses toward foundational discipline principles, with

reduced emphasis on systems or leadership. In addition, it is likely that most students with a M.S. degree in the discipline do not require a reiteration of its key principles. Therefore (assuming typical M.S. discipline competence) entering students would not take the Discipline Awareness course in their primary discipline, but would take the courses in their secondary disciplines. This addresses the Classroom Dilemma, in that all students in the 8301 series classes would have a similar (limited) background in that discipline's core principles. Competence in Discipline Awareness/Principles would be enhanced via encouraging students to act as teaching assistants in undergraduate discipline courses. Thus, after the completion of two semesters in the program, Ph.D. student would have a reasonably similar foundation in Discipline Principles, and would be ready to advance into the Methods CL for Systems and Discipline CA.

The MAS program model provides a more specific role for Leadership than typical programs that often claim some aspect of Leadership as an objective. If the Producer –Trader model is accepted, then the MAS graduate must possess significant Leadership skill, The graduate must communicate with discipline professionals, negotiate compromises between discipline products and discipline representatives, gain access to discipline research data, and communicate the value of systems activities and research. Students propose to strengthen the Leadership curriculum by adding a three-hour course.

Students propose that systems research under the MAS program model must focus on linking discipline research data. This may be accomplished in several ways. Foremost, the MAS program researcher might seek existing discipline data, especially descriptive relationships, mathematical functions or equations, or established models used in the discipline. The research would then consist of using these established relationships in systems models. Alternatively, MAS research might be similar to current discipline research that is focused on detecting differences between relatively few treatments important to a specific discipline. Such answers would still be sought, but with the view that someone else might wish to use the data in a systems model. The research must then be structured in such a way that the resulting data provides functions and relationships in addition to the specific treatment results of interest.

Conclusions

Modeling of an entire program is not a one-time activity, rather it is an ongoing process. The AGRI 8303 Modeling Project provided a beneficial experience to students. The project encouraged critical thought about a real systems issue, provided introductory modeling experience, and opportunity to apply systems principles to a real project. The experience also reinforced the desirability of working on actual problems as a learning method, as opposed to contrived example exercises.

The MAS program objective model offers a number of advantages to the WTAMU program. Primarily, it provides a unique aspect and competitive advantage to WTAMU and its graduates. Practically, it faces fewer obstacles than other models evaluated or proposed. The MAS model also faces risk, due to its novelty. However, any new Ph.D. program faces

uncertainty and risk, and the MAS model risk is likely no greater than that of alternative models.

Many systems problems are solvable with a structured effort. Identification of the importance of Methodology CL led to the discovery that Systems Methodology in the current program needed to be strengthened. Once realized, various solutions to the weakness are available. Similarly, a proposal to resolve the Classroom Dilemma (restructure courses and add teaching activity) became apparent as the model developed. Management of agriculture systems research in the program will likely become more clearly focused as emphasis on Systems Methodology is strengthened. Formal modeling of complex systems problems may lead to recognition of unanticipated problems, and solutions.

Additional effort is required to more fully model the program. Areas of future interest might include more detailed models of flows and feedbacks within the curriculum and research components of the program. Course-course, course-research, discipline-discipline, and other interactions all await description and inclusion in the program model. Each addition to the model may require surveys, data collection, analysis of existing data, or other techniques. Availability of material for future systems modeling projects is assured.

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