INTERCOLLEGIATE ATHLETIC DEPARTMENTS PERFORMANCE ASSESSMENT

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Abstract

Like other organizations, United States intercollegiate athletics departments face the challenge of operating efficiently and effectively. Performance measurement in this environment is made more challenging by the need to be successful both on and off the playing fields. With its focus on structural performance contributions, system dynamics modeling works well with data envelopment analysis, which is focused on input-output relationships, to provide a more complete understanding of performance measurement and assessment. This combined understanding supports policy analysis that contributes to performance improvement opportunities. This research outlines the success achieved by linking these two approaches, even with the system dynamics contribution limited to a qualitative model.

Keywords: System dynamics, Data envelopment analysis (DEA), Performance measurement

Overview

As United States college and university administrators face increasing pressure to reduce costs, their focus frequently turns to non-academic programs, of which the most visible is often the intercollegiate athletics department ("Athletics"). As a result, Athletics departments, which can be viewed as businesses generating annual revenues up to 75 million dollars, desire to demonstrate that they are good stewards of the resources available to them, and that they are efficiently and effectively achieving their missions.

However, the challenge that the departments face is demonstrating their level of performance to all of their key stakeholders - who combine to hold the departments accountable for success both on the playing field and in the business office. Alumni and students are focused on the highly visible performance of the teams. University administrators and legislators are focused on reducing academic funding levels linked to tax rates, while not harming the universities' perceived value as judged by its athletics performance. Taxpayers, particularly alumni of an institution, are interested in achieving both goals at the same time.

Winning percentage and profitability are difficult to reconcile into a balanced performance measurement system. Trying to compare these measures across different sports, like football, wrestling, and swimming and diving increases the complexity.

Additionally, once the performance measures are defined and reported, Athletics administrators face the challenge of comparing performance results from institution to institution, given the variances with the environments in which the departments operate. Fortunately, these variances tend to focus primarily on environmental parameters, rather than the structural environment.

Data envelopment analysis (DEA) provides a methodology for assessing organization performance in a multi-factor environment, focusing on the key inputs and outputs to the organization. However, DEA does not shed much light on the structural impact on performance. System dynamics (SD) is focused on how structure contributes to organization performance over time. Traditionally, SD models focus on behavior modes, rather than identifying optimum performance levels, providing a further complement to DEA.

Research Overview

This research project focuses on linking the two performance assessment approaches, so that analysts can build on the strengths of both approaches. SD contributes to assessment of endogenous, structural contributions over time and DEA focuses more on identifying optimum levels within a time period, allowing comparisons of organization performance.

The initial objective of this research was to provide a DEA framework for identifying high performing intercollegiate athletic departments and suggest best candidates for benchmarking to drive Athletics performance improvement.

Since DEA focuses on productivity assessment without strong consideration of the organization structure, the research also sought to utilize system dynamics modeling to reveal the organization structure. The development of an initial causal loop diagram model forms the basis for linking the DEA productivity analysis to the system behavior suggested by the structural model.

The development of the DEA model and SD qualitative model set the stage for policy analysis triggered by DEA results and focused by consideration of structure captured with the causal loop diagram.

Athletics Department Process Overview

The basic production process for Athletics departments involves the conversion of financial resources into the resources required to conduct sporting events and achieve results. This process supports the Athletics department goal of sustaining athletic success while also achieving desired financial and academic success levels.

Even though their operation is within the overall university structure and is impacted by guidelines from academic and external sources, including the NCAA, the fundamental process can be considered to be similar to the operation of professional athletics and entertainment organizations.

For this study, Athletics departments from the Atlantic Coast (ACC) and Southeastern (SEC) Conferences were targeted. Even though the locations of member institutions range from Massachusetts down to Florida and over to Arkansas, membership in either the ACC or the SEC creates a common foundation for performance, including requirements for participation by the member institutions.

The primary production process input is funding, which is utilized to procure coaching staffs, facilities, materials, and student-athletes. In addition, the funding resources provide the operational resources for delivering events. This funding comes from ticket revenues, media contracts, licensing revenue, development foundation contributions, and institutional support.

Another critical input for this study is the collection of policies that guide decision making within the organization. As will be discussed, organizations have some variability regarding how they both define and pursue success, particularly when multiple sports are involved.

Both the funding and the policies are transformed to yield Athletics success, on and off the field. In the DEA model, success on the field is measured by winning percentages. The qualitative SD model provides some more flexibility in that a measure of success does not have to be defined at this point. However, "on-the-field success" is part of the model. Financial success is measured more traditionally utilizing annual profit, or the difference between revenues and expenses.

The top level process models that each approach utilizes provide a strong indication of the differences in the approaches (Figures 1 and 2). The input-output focus of DEA is highlighted, as is the structural feedback relationship focus of system dynamics.

Figure 1. Data Envelopment Analysis Model

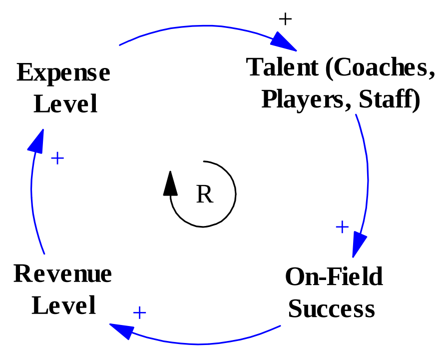

Figure 2. Basic System Dynamics Model

Even though the Athletics departments in the study come from the same athletics conferences, forming a common ground for comparison, their performance could be significantly impacted by the environment in which they operate. Therefore, in addition to assessment of differences between the conferences, consideration will be given to the size of the university community, to the type of university community, rural or urban, and to the type of institution, public or private (Appendix A). These DEA classification factors can be considered to see if they have to be considered as endogenous factors in the system dynamics model or if they are exogenous.

Literature Review

A search of the literature returned no studies specifically related to using system dynamics to improve performance assessment in athletics. However, continued searching did reveal a few published studies in the athletics management literature that have attempted to identify the factors which lead to desired outcomes for intercollegiate athletic programs.

One paper reported research that applied DEA in professional athletics (Sexton and Lewis 2003). The study used DEA to evaluate the effectiveness of major league baseball franchises. One interesting feature of this model was that the decision-making unit (DMU) was broken down into two stages, acquisition and production, reflecting the structure of the system at a high level. Specifically, the acquisition phase refers to the ability of the front office to acquire sufficient talent and the production phase refers to the ability to convert talent into wins. A production frontier was developed to identify franchises that exhibited best practice behaviors in both stages of operation.

Doyeon Won of Ohio State University analyzed the university resources that are highly correlated with measures of athletics success (Won 2001). The tested model, based upon confirmatory factor analysis, determined that intangible resources, like history and reputation of the university, lead to greater amounts of tangible resources, including human resources and capital, which lead to higher measures of athletic success. However, this research was somewhat limited since, in many cases, surrogate measures had to be used to represent the variables of interest.

Other research specifically investigated the resources that lead to success for collegiate football programs (Smart and Wolfe 2000). Using the Barney classification scheme of a firm's resources as the independent variables, which include physical capital, human capital, organizational capital, and financial capital, their key finding was that organizational resources that cannot be easily duplicated by other universities are the key sources of competitive advantage.

Econometrics research also provided information for both the DEA and SD models. One study identified thirteen of the independent variables that are responsible for variations in fund raising revenues among Division I-A athletic programs (McEvoy 2005).

DEA Model Development

The variables for this project are aggregated at a top level for the DEA analysis. This level of aggregation supports a small number of variables, enabling a successful analysis with the relatively small number of DMU's utilized in the study.

While this aggregation allows the development and analysis of the model, it also introduces some limitations on interpretation of the results since the variable components at a lower aggregation level can be quite volatile. For example, revenue sources disaggregate into revenue from categories including ticket sales, contributions, advertising, and conference support. Each of these areas can react differently to factors, both endogenous and exogenous. Continuing work in this area would benefit from a larger study at a lower aggregation level to determine the impact of the choice of aggregation level.

The key input variable used in this analysis is funding. This funding is used to perform all transformation activities of the athletic department, including acquisition of coaching talent, development of athletic talent, and the actual management of the events.

The financial data, both expenses and revenues, were obtained from the United States Department of Education's (DOE) Equity in Athletics database (US DOE 2005). Each institution with an athletics program is required to self-report various measures of performance to the DOE, including revenues, expenses, and the number of athletes participating in each sport. While this data has been gathered for several years, the National Collegiate Athletics Association (NCAA), which stewards the data collection process, considers only the most recent data, for 2004-05, to be consistent across institutions (Appendix B).

The amount of funding that supports each athletic department is determined by the expense information that is reported to the Equity in Athletics database. Athletic department expenses are reported in the following categories: basketball (men's and women's), football, total expenses of all other sports (men's and women's), and expenses not allocated by gender or sport.

Since specific expense information is only provided for three sports (men's and women's basketball and football), performance in these sports formed the basis of this performance measurement study. The study is also limited to these three sports since the majority of expenses are consumed by these sports and vast majority of revenue is produced by these sports. In addition, every ACC and SEC institution fields football and men's and women's basketball teams. Other sports may not be sponsored by every ACC and SEC member institution.

The key challenge was how to include expenses that are not allocated by gender or sport into the measurement study. This figure represents overhead and may include such expenses as athletic department administration salaries as well as grounds and maintenance crews salaries and expenses.

To fairly distribute these expenses back to the three sports that form the basis of the study, the following approach was taken. First, the percentage of total direct costs that are assigned to football and men's and women's basketball expenses was calculated. This percentage was multiplied by total non-allocated expenses to determine the levels of overhead expenses to include in the study. Using this approach distributes the majority of non-allocated costs back to the three major sports since the effort required to manage these events is significantly larger than those of other sports the departments offer.

Program revenue and success on the playing field are the two main output variables in this model.

Revenue is reported in the same categories of the Equity in Athletics database as are used for expense reporting. The only revenue categories that are included in the model are revenues directly attributable to men's and women's basketball and football (Appendix C). Non-allocated revenues are not included in the model because this figure includes money that comes from sources such as state governments and student fees, revenues that are not actually generated by the athletic departments.

One revenue component that is very difficult to account for in this model is revenue generated from fundraising and endowments. These funds are given directly to athletic departments by alumni and boosters of the university and are typically quite substantial relative to other revenue sources at the major college level, which includes the ACC and SEC programs. Realistically, the majority of fundraising revenue is given in order to receive benefits associated with one of the major sports programs, football or basketball. However, this money usually officially goes into a general fund for the support of the entire athletics program. NCAA guidelines for reporting revenue require that fundraising money be reported as revenue for a specific sport if it is used to directly cover an expense, such as scholarship costs, or if the booster restricts the donation for a specific sport. Because of this, more detailed financial statements will be required from each institution in order to accurately account for revenue that is not attributable to a specific sport.

Success on the field is measured as the average of the winning percentages of the three sports included in this study (Appendix D). Both regular season and postseason games are included in the average. In this calculation, it is possible that a team can be penalized for qualifying for a postseason event, such as a bowl, and then losing. However, given that a total of approximately 70-80 contests are included in the overall average for each team, these effects are anticipated to be negligible. The NCAA was the source of team performance data in the various sports (NCAA 2005).

DEA Methodology

DEA evaluates the performance of an organizational unit or decision making unit (DMU) by weighting each output and each input to generate a ratio of virtual output to virtual input. The input and output weights are determined by the solution of the linear program and consist of the optimal set of weights for the DMU under investigation. Assignment of optimal weights to the DMU under investigation helps to define the peers of the decision-making unit (Cooper et al 2000) and the calculation of specific performance targets for each input and output (Boussofiane et al 1991). The virtual output and virtual input ratios are then computed for each DMU to generate an efficiency score. The BCC model, where the inputs (resources) are minimized and variable returns to scale is assumed as follows (Banker et al 1984):

$$\min h - \varepsilon\left[\sum_{i=1}^{m} s_i^{+} + \sum_{r=1}^{t} s_r^{-}\right]$$

subject to

$$h x_{ij_0} - \sum_{j=1}^{n} x_{ij}\lambda_j - s_i^{-} = 0, \quad \mathrm{i} = 1,\ldots,\mathrm{m}$$

$$\sum_{j=1}^{\mathrm{n}} y_{rj}\lambda_j - s_r^{+} = y_{r_0}, \quad \mathrm{r} = 1,\ldots,\mathrm{t}$$

$$\sum_{\mathrm{j}=1}^{\mathrm{n}} \lambda_{\mathrm{j}} = 1 \qquad \lambda_{\mathrm{j}}, s_i^{+}, s_r^{-} \geq 0$$

where,

y_{rj} = amount of output r from unit j

x_{ij} = amount of input i to unit j

n = the number of DMU's

t = the number of outputs

m = the number of inputs

ε = small positive number

λ_{j} = composite unit multiplier

s_r^{-} = output slack

s_i^{+} = input slack

DMU's with an efficiency score of one are defined as efficient and become members of the best-practice frontier. The efficiency scores of all other DMU's represent either the percentage by which inputs must be reduced or the percentage by which outputs must be increased for the DMU to become efficient. The solution to the linear program for inefficient DMU's also provides reference groups that can be used in benchmarking for improvement.

Variations of DEA models can also be run depending upon whether or not the target systems are believed to exhibit constant or variable returns to scale. The CCR model assumes that all DMU's are producing along the constant returns to scale portion of their production frontier (Charnes et al 1978). On the other hand, the BCC model allows for variable returns to scale and as a result also considers inefficiency in terms of a DMU's scale of operations. The comparison of the efficiency scores from the two models allows for identification of production congestion. All of this information can aid in making decisions in terms of resource distribution among DMU's (Boussofiane et al 1991).

DEA Results

An input orientation where the performance evaluation is based on the extent to which resources are used efficiently for a given level of output achievement was used in the DEA models for two key reasons. First, the athletic departments under investigation are only able to directly control their input, expenses. Athletic department outputs, revenue and winning percentage, cannot be directly controlled like typical product oriented outputs in production systems. As a result, input reducing efficiency scores are more useful in this analysis. Second, the selection of input and output orientation does not change the efficient frontier generated by a particular model; it only changes how inefficient units are projected onto the frontier (Charnes et al., 1994).

Three DMU’s, Georgia from the SEC and Boston College and North Carolina State from the ACC, are on the efficient frontier in the CCR model while two additional DMU’s, Louisiana State and Mississippi State, SEC programs, are fully efficient in the BCC model (Table 1).

Since returns to scale significantly impact results, the BCC-I model will be used as a baseline for conducting further analysis. The BCC model allows for variable returns to scale. The CCR model’s assumption that constant returns to scale exist along the production function does not seem to be valid in the case of athletic departments. At some point, an increase of inputs has to lead to a less than proportional increase in outputs since there is a theoretical maximum amount of revenue that can be made in a sport. For example, once a team reaches championship caliber status it can no longer increase its revenue from postseason appearances.

Table 1. Efficiency Scores

Institution	2004-2005 CCR-I	2004-2005 BCC-I
ACC		
Boston College	1.0000	1.0000
Clemson	0.6406	0.7562
Duke	0.7776	0.7809
Florida St.	0.9570	0.9596
Georgia Tech	0.7937	0.8035
Maryland	0.6875	0.6931
Miami (Fla.)	0.7395	0.7434
North Carolina	0.8172	0.9440
North Carolina St.	1.0000	1.0000
Virginia	0.5195	0.5202
Virginia Tech	0.8231	0.8288
Wake Forest	0.9688	0.9820
SEC		
Alabama	0.7867	0.8043
Arkansas	0.7285	0.7700
Auburn	0.7591	0.7976
Florida	0.5590	0.5591
Georgia	1.0000	1.0000
Kentucky	0.5935	0.6394
Louisiana State	0.7977	1.0000
Mississippi	0.8505	0.9330
Mississippi St.	0.9791	1.0000
South Carolina	0.6940	0.7788
Tennessee	0.5367	0.5699
Vanderbilt	0.6753	0.7182

Once the efficiency scores from DEA are obtained, performance targets for DMU's that do not lie along the efficient frontier can be calculated. The BCC-I efficiency scores represent the percentage of each input that should have been used in order to produce the generated outputs. Therefore, in this model, the performance targets represent the level of expenses needed to efficiently produce the observed revenue and winning percentages (Table 2).

Table 2. Performance Targets

Institution	BCC-I Score	Observed Expenses	Target Expenses	Performance Gap
ACC				
Boston College	1.0000	$23,431,767	$23,431,767	$0
Clemson	0.7562	$26,333,193	$19,912,592	($6,420,600)
Duke	0.7809	$26,153,223	$20,422,420	($5,730,803)
Florida St.	0.9596	$22,234,269	$21,335,619	($898,649)
Georgia Tech	0.8035	$23,021,004	$18,496,703	($4,524,301)
Maryland	0.6931	$27,720,285	$19,212,928	($8,507,357)
Miami (Fla.)	0.7434	$26,374,912	$19,606,338	($6,768,575)
North Carolina	0.9440	$31,801,381	$30,019,004	($1,782,376)
North Carolina St.	1.0000	$20,389,693	$20,389,693	$0
Virginia	0.5202	$41,622,570	$21,652,279	($19,970,291)
Virginia Tech	0.8288	$27,301,609	$22,627,708	($4,673,901)
Wake Forest	0.9820	$18,842,136	$18,503,558	($338,578)
SEC				
Alabama	0.8043	$31,284,560	$25,162,748	($6,121,812)
Arkansas	0.7700	$29,480,736	$22,699,915	($6,780,820)
Auburn	0.7976	$34,203,404	$27,282,292	($6,921,113)
Florida	0.5591	$45,531,573	$25,455,248	($20,076,325)
Georgia	1.0000	$26,498,830	$26,498,830	$0
Kentucky	0.6394	$32,979,313	$21,085,642	($11,893,671)
LSU	1.0000	$36,098,469	$36,098,469	$0
Mississippi	0.9330	$19,192,260	$17,906,094	($1,286,167)
Mississippi St.	1.0000	$16,757,931	$16,757,931	$0
South Carolina	0.7788	$24,638,987	$19,188,362	($5,450,625)
Tennessee	0.5699	$47,378,021	$27,002,026	($20,375,995)
Vanderbilt	0.7182	$25,563,544	$18,358,669	($7,204,875)

Once performance targets are found, peers for the inefficient DMU's can be identified from among the efficient DMU's. These peers can be targeted as benchmarking organizations. Perhaps not surprisingly, the efficient SEC departments are most often identified as peers for other SEC departments and the ACC departments are most often linked with other ACC departments.

Further DEA analyses were completed to determine that the conferences did not demonstrate significantly different efficient frontiers. Rural and urban-based institutions demonstrated limited differences in their abilities to win on the playing field. However, the rural institutions were more efficient in converting expenses into revenues. Consideration of the impact of public (state-supported) versus private did not identify differences in the efficiency frontiers.

The DEA model provides administrators at each institution with a performance target to be met in order to reach the efficient frontier. In addition, peer groups are identified for each inefficient decision making unit. This may be the most beneficial aspect of this study since it is not a bad thing in itself to spend a large amount of money on an athletics program, if revenue and team success targets are reached. The institution, however, must have the capacity to generate a large amount of revenue in order to balance the expenses. Each inefficient institution will be able to benchmark best practices of its peer group and thus devise its approach for reaching the frontier.

System Dynamics Model Development

While the DEA analysis identified peer organizations, the analysis does not provide insight into what portions of the organizations should be benchmarked. However, there is a suggestion from the peer analysis of the importance of structure. While SEC member Georgia is primarily a peer for other SEC departments, it is also identified as a peer for the five ACC departments with the largest football stadiums. Georgia has the fifth largest football stadium in country.

An additional indication of the importance of structure is found when the private versus public institution comparison is revisited. None of the private institutions are classified as profitable, given the definition used in this study, in the three major sports. This suggests that private institutions have a different approach to being efficient than the public institutions.

DEA primarily focuses on the relationships between inputs and outputs without giving strong consideration to the underlying structure of the production function. System dynamics modeling tools provide opportunities to explore the structure of the system. In general, system dynamics tools are either qualitative or quantitative in nature. The qualitative tools focus on revealing system structure, including components and relationships. The quantitative tools focus on the flows of stocks of materials or information into, through, and out the system.

For this research, the DEA model provides a quantitative view of the system performance. Therefore, a qualitative system dynamics model was developed to complement the DEA model and provide more information for understanding the productivity results that organizations are achieving.

Behavior Modes

The behavior mode displayed by Athletics departments builds from the goal-seeking behavior archetype and can also be represented by the more complex modes associated with growth: S-shaped growth, growth with overshoot, and overshoot and collapse (Sterman 2000).

Mature, seemingly stable departments operating in a conservative fashion seem to exhibit goal-seeking behavior, reflecting the overall performance goals of the organization.

Other departments are striving to perform at an improved level, with random variation around that level. This behavior mode resembles S-shaped growth, where the system state is limited by the carrying capacity of the system. For this system, capacities for all expenses and resources must be considered.

Depending on the structure of the delays in the system, this behavior mode could also take the form of growth with overshoot. This behavior mode could be found in departments that react quickly, perhaps too quickly to perceived opportunities. While they achieve success, they also exceed the carrying capacity of the system for at least one of the resources.

Finally, the department could be subject to pressures on the system carrying capacity. If the capacity were to decline significantly, this could lead to the collapse of the organization from its current level to a level that could be sustained.

Causal Loop Diagram

A causal loop diagram (CLD) captures key components of a system and how those components are related to each other. In particular, the CLD focuses on the feedback relationships that have the most significant impact on the performance of the system.

Often, a CLD is developed at a highly aggregated level. Maintaining a high level of aggregation allows the qualitative model to exhibit a high level of clarity for observers. The quantitative model developed from the qualitative model may or not be at the same level of aggregation.

CLD models typically start with the identification of archetypes, or basic mechanisms, that exist in the system being modeled. Using the archetypes helps to focus the model and also encourage the modeler to include relevant components and relationships. Two relevant basic archetypes are presented as examples. The Exponential Growth Archetype (Figure 3) reflects a reinforcing loop that generates growth without limits. The Goal Seeking Behavior Archetype (Figure 4) represents a system that seeks a target level in its behavior.

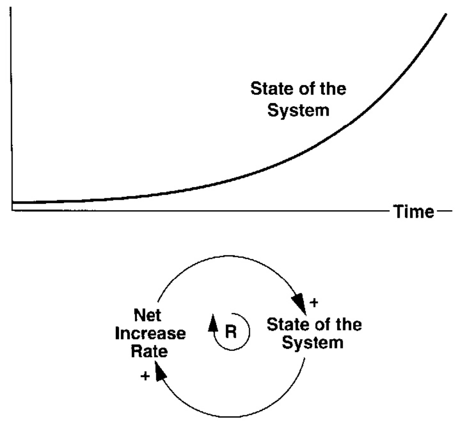

Figure 3. Exponential Growth Archetype (Sterman 2000)

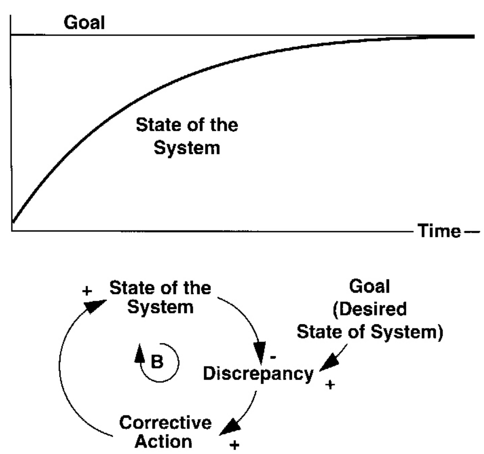

Figure 4. Goal Seeking Behavior Archetype (Sterman 2000)

The Athletics Performance System has two primary performance areas to consider: off-field performance and on-field performance.

The off-field performance focuses on financial performance. At the top level, net cash flow, or revenue less expenses, measures financial performance. Independently, revenues and expenses both demonstrate behavior that suggests that the Goal Seeking archetype is an appropriate basic model.

In both cases (Figure 5), the state of the system, the expense or revenue level, is compared to the revenue or expense potential of the system to determine a discrepancy. This discrepancy then drives the potential change in level, serving as the corrective action. Working together, each loop serves to balance or moderate performance. Quantitative modeling may suggest that the more complex growth-focused behavior modes might more effectively represent this behavior.

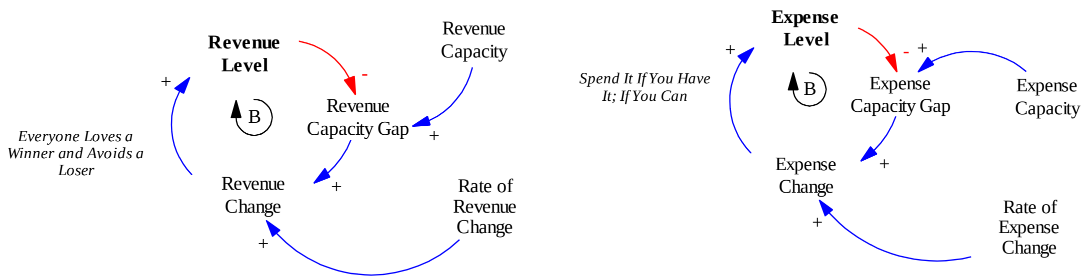

Figure 5. Balancing Loops: Revenues and Expenses

On the other hand, the talent of the personnel, including the coaches, athletes, and staff members, drives on-field performance in the system (Figure 6). Considered independently, the on-field performance improves as the talent pool improves, which serves to reinforce further improvement in the on-field performance. This type of performance suggests an Exponential Growth archetype is appropriate as a basic mechanism.

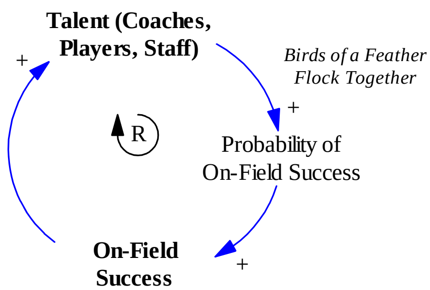

Figure 6. Reinforcing Loop: Talent

On a larger scale, a reinforcing loop exists to relate the three basic mechanisms (Figure 7). When more revenue is available, then more money can be expended, which results in an increase in the talent pool, contributing to improving on-field performance. Again, an Exponential Growth basic archetype is appropriate at the top level.

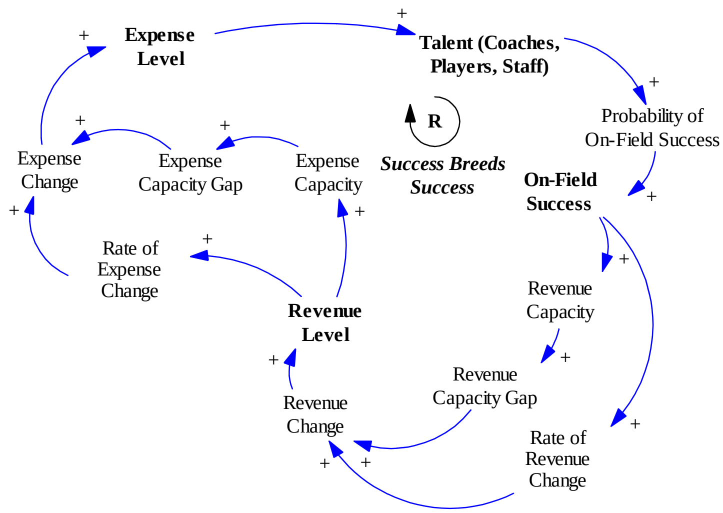

Figure 7. Reinforcing Loop: Success

The basic mechanisms in the system (Table 3) are then brought together to create the causal loop diagram for the overall Athletics performance system (Figure 8).

Table 3. Feedback Loops

Loop Name	Feedback Loop Type	Focus
Success Breeds Success	Reinforcing	Overall relationships between talent, revenues, and expenses
Birds of a Feather Flock Together	Reinforcing	How personnel impacts on-field performance
Everyone Loves a Winner and Avoids a Loser	Balancing	The rise and fall of program revenues
Spend It If You Have It; If You Can	Balancing	The rise and fall of program expenditures

The reinforcing talent loop is linked to the revenue loop by relationships between on-field success and the level of revenue capacity and the rate of revenue change. The system suggests that these are positive linkages, that is, the revenue levels move in the same direction as on-field success. For example, in the positive direction, on-field success gives a program access to more revenue potential and also increases the rate at which revenue is generated.

Similarly, the revenue loop links to the expense loop through relationships between the revenue level and the expense capacity and rate of expense change. This relationship also is anticipated to have a positive polarity.

Finally, the expense loop links with the talent loop through the level of expenses and the level of talent that can be obtained at that expense level. This relationship also maintains a positive polarity and closes the reinforcing success loop.

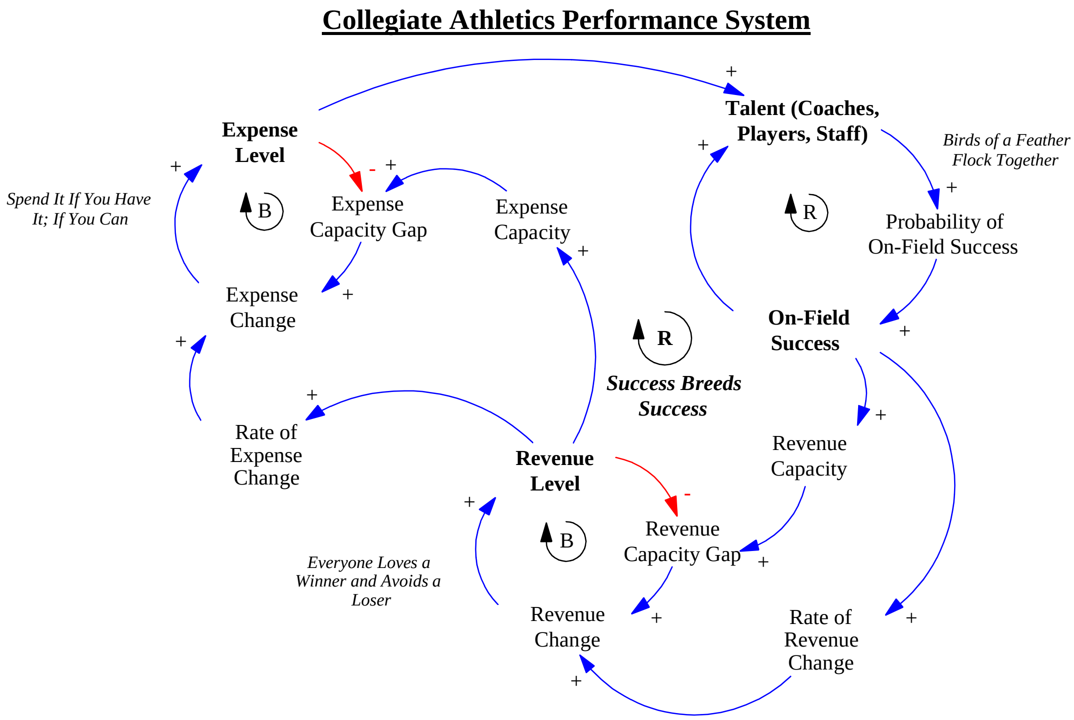

Figure 8. Causal Loop Diagram

Remember that this model has been developed at a highly aggregated level. Development of the quantitative model will require at least one level of disaggregation. For example, the revenue loop will need to be disaggregated into components for ticketing, contribution, royalty, and media revenue.

System Dynamics Model Insights

While the causal loop diagram is a qualitative tool, the documented structure does provide some insight linking the key input from the DEA model, the expenses, with the key outputs of the DEA model, the winning percentages and the revenues.

Note that the aggregated CLD provides the basis for a quantitative model that would parallel the DEA model. This provides the capability for testing the disaggregated quantitative system dynamic model using the aggregated data and results from the DEA model. The disaggregated data should be available from the original source data that forms the basis for the EIA data publicly reported.

The CLD structure highlights the balancing loops that moderate the system performance. In particular, the revenue and expense capacities hint at being overly powerful in the overall system performance.

However, the structural model also suggests that the feedback relationships between input and outputs might create a correlation impacting the DEA calculations. This raises the importance of further consideration of a longitudinal DEA study.

While the DEA analysis will identify athletics departments that are not performing efficiently, the system dynamics models, qualitative and quantitative, can provide information for identifying structural differences between inefficient organizations and their peers on the efficiency frontier.

As mentioned, the causal loop diagram for this system suggests a key component of the system could be the capacity for the organization to generate revenue. Many factors have to be considered when analyzing the organization's revenue capacity (Table 4). While many of the factors rely on alumni support, some of the factors also extend well beyond the traditional alumni database.

Table 4. Revenue Capacity Factors

Revenue Category	Key Analytical Factors
Ticketing	Venue size, number of events, demand (alumni and fan base, entertainment competition), pricing
Royalties	Demand (alumni and fan base) for licensed items
Contributions	Alumni and fan base (current and future) and loyalty levels
Media	Market size for various media

However, calculation of a sustainable revenue capacity potentially could be critical in determining a sustainable expense capacity. In turn, the causal loop diagram suggests that the expense levels are what determine the talent level. Again, a sustainable expense level drives determination of a sustainable talent level.

The potential policy analysis would be to determine how sustainable revenue capacity first could determine sustainable expense levels at the aggregated levels. Of potentially greater decision-making value would be to recommend policies for the expense factors at a disaggregated level.

For example, the investment in coaching staffs could be studied in the light of a sustainable level for coaching talent acquisition. The model suggests that there are limitations that should be considered before acquiring a high-profile, highly compensated coaching staff, particularly if the program is near its sustainable revenue capacity.

Another policy analysis suggested by the model is the determination of the impact of venue expansion on the long-term capability of the organization to maintain the facility after the capital investment. While the short-term demand may exist to support the capital investment, the organization might not have the capability to maintain the facility and reap the long-term benefits of the expansion.

Capital investments become even more challenging when those investments are in assets that do not directly generate revenue, including administration facilities or fitness centers. These investments incur on-going expenses that can cause total expenses to exceed the sustainable expense levels and result in decision-making steps to shift expenses from one category to another, which can impact the ability of the organization to maintain talent levels.

Future Research Opportunities

Neither traditional statistical techniques nor DEA shed light on the endogenous structure that contributes to performance. DEA identifies underperformance based upon optimization. The utilization of system dynamics modeling can provide insight linking system-based causes with underperformance. Combining the DEA and SD analyses could enhance decision-making support for athletic department administrators to effectively consider investment in facilities and talent.

More generally, the opportunity exists to strengthen the linkage between the two methodologies. Research has been conducted already in this area (Vaneman 2002). This application lends itself well to supporting furthering of the initial work.

The initial causal loop diagram of this system suggests that sustainable performance could be constrained by revenue capacity for each department. However, to confirm this supposition, a quantitative system dynamics model should be developed and utilized. Initial development indicates that the capacitated loops, along with the delay functions on the links between the key loops, will be the critical components of the model. As mentioned in this research, the quantitative model will probably require a move to a lower level of aggregation to reflect the various sub-component capacities and the delay functions.

In this study, the performance of athletics departments from only two conferences was assessed. As a result, opportunities exist to assess departments from other major conferences from across the country and to consider independent major programs.

There are also major college programs that bring a significantly different emphasis on the balance between football and basketball programs. In addition, there are two other NCAA levels that limit the investments, primarily financial aid that colleges and universities can make in their athletics programs. Future research can investigate how efficiency is impacted in organizations in these divisions.

The DEA model can also be enhanced in terms of its level of detail to consider other inputs and outputs, such as academic performance. Starting in the 2005-2006 academic year, feedback regarding academic performance will be provided via the NCAA's Academic Progress Rate (APR) calculation.

Conclusions

The results from the DEA analysis support the research hypothesis that high performing intercollegiate athletic departments can be identified along with best practice candidates for benchmarking. This information can be used in conjunction with system dynamics modeling to better understand the structural improvements that need to be made to the system in order to improve performance.

Successfully modeling a structure for the production function of a collegiate athletics department suggests that the comparison of athletic departments with DEA is appropriate, since an underlying common production function can be assumed.

The DEA approach successfully identified efficiency frontiers for the overall data and for the various categories. Intuitively, the results appear consistent with actual performance. However, the model also points out the limitation of DEA for assessing the structure of an organization since sources of efficiency differences are not immediately apparent.

Fortunately, a causal loop diagram suggests that the linkages between the inputs and outputs can be assessed using system dynamics tools. The causal loop diagram and subsequent quantitative system dynamic models support assessment of how the structure impacts the performance of the system.

The obvious next step for the system dynamics analysis is the development of quantitative models to allow the assessment of structural impacts on organizational performance. The timeframe for this project did not allow for the collection of data necessary to develop and test quantitative models. This data will not only need to be disaggregated, but should also be supportive of longitudinal study.

Combining the DEA and SD analyses will provide decision making support for athletic department administrators to effectively consider investment in facilities and talent, particularly given proof that the expense and revenue capacities actually generate the moderating forces in the structure.

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Appendices

A. Demographic (MSA) Information
B. 2004-2005 Expenses
C. 2004-2005 Revenue
D. 2004-2005 Winning Percentages

Appendix A: Demographic Information

ACC

Name	Location	MSA Code	Name	Size	U/R (250k)	Public/Private	Category
Boston College	Chestnut Hill	14460	Boston-Cambridge-Quincy, MA-NH	4391344	Urban	Private	3
Clemson	Clemson		none	11096	Rural	Public	2
Duke	Durham	20500	Durham, NC	426493	Urban	Private	3
Florida St.	Tallahassee	45220	Tallahassee, FL	320304	Urban	Public	1
Georgia Tech	Atlanta	12060	Atlanta-Sandy Springs-Marietta, GA	4247981	Urban	Public	1
Maryland	College Park	47894	Washington-Arlington-Alexandria, DC-VA-MA	4796183	Urban	Public	1
Miami (Fla.)	Miami	33100	Miami-Fort Lauderdale-Miami Beach, FL	5007564	Urban	Private	3
North Carolina	Chapel Hill	20500	Durham, NC	426493	Urban	Public	1
NC State	Raleigh	39580	Raleigh-Cary, NC	797071	Urban	Public	1
Virginia	Charlottesville	16820	Charlottesville, VA	174021	Rural	Public	2
Virginia Tech	Blacksburg	13980	Blacksburg-Christiansburg-Radford, VA	151272	Rural	Public	2
Wake Forest	Winston-Salem	49180	Winston-Salem, NC	421961	Urban	Private	3

SEC

Name	Location	MSA Code	Name	Size	U/R (250k)	Public/Private	Category
Alabama	Tuscaloosa	46220	Tuscaloosa, AL	84700	Rural	Public	2
Arkansas	Fayetteville	22220	Fayetteville-Springdale-Rogers, AR-MO	347045	Urban	Public	1
Auburn	Auburn	12220	Auburn-Opelika, AL	115092	Rural	Public	2
Florida	Gainesville	23540	Gainesville, FL	232392	Rural	Public	2
Georgia	Athens	12020	Athens-Clarke County, GA	166079	Rural	Public	2
Kentucky	Lexington	30460	Lexington-Fayette, KY	408326	Urban	Public	1
LSU	Baton Rouge	12940	Baton Rouge, LA	705973	Urban	Public	1
Mississippi	Oxford	37060	Oxford, MS	9984	Rural	Public	2
Mississippi St.	Starkville	44260	Starkville, MS	19900	Rural	Public	2
South Carolina	Columbia	17900	Columbia, SC	647158	Urban	Public	1
Tennessee	Knoxville	28940	Knoxville, TN	616079	Urban	Public	1
Vanderbilt	Nashville	34980	Nashville-Davidson—Murfreesboro, TN	1311789	Urban	Private	3

Appendix B: 2004-2005 Expenses

	Name	FB Expenses	MBB Expenses	WBB Expenses	Not Allocated Expenses	Overhead (NA) Allocation	Major Sports Expenses
Atlantic Coast Conference (ACC)	Boston College	$11,064,328	$2,532,575	$1,645,065	$12,869,052	$8,189,799	$23,431,767
	Clemson	$10,512,496	$3,444,307	$1,627,767	$16,136,163	$10,748,623	$26,333,193
	Duke	$9,314,704	$7,400,772	$2,268,777	$10,920,811	$7,168,970	$26,153,223
	Florida St.	$9,137,462	$2,931,747	$2,104,175	$13,010,154	$8,060,885	$22,234,269
	Georgia Tech	$6,433,063	$2,349,988	$1,392,008	$20,853,540	$12,845,945	$23,021,004
	Maryland	$9,301,052	$3,465,662	$1,923,330	$21,756,165	$13,030,241	$27,720,285
	Miami (Fla.)	$10,679,344	$2,888,925	$2,053,072	$16,174,812	$10,753,571	$26,374,912
	North Carolina	$10,531,683	$4,845,388	$1,611,399	$22,687,656	$14,812,911	$31,801,381
	North Carolina St.	$5,157,534	$2,438,502	$1,417,188	$17,374,800	$11,376,469	$20,389,693
	Virginia	$16,812,582	$9,043,477	$4,982,676	$14,874,043	$10,783,835	$41,622,570
	Virginia Tech	$13,842,147	$2,618,304	$1,904,841	$12,245,021	$8,936,317	$27,301,609
	Wake Forest	$7,771,751	$3,595,963	$1,683,634	$8,862,821	$5,790,788	$18,842,136
Southeastern Conference (SEC)	Alabama	$14,106,325	$3,674,978	$1,871,141	$18,515,320	$11,632,116	$31,284,560
	Arkansas	$11,695,261	$5,560,359	$2,417,154	$14,701,808	$9,807,962	$29,480,736
	Auburn	$16,374,577	$3,619,519	$2,307,976	$17,675,113	$11,901,332	$34,203,404
	Florida	$16,144,658	$4,649,529	$2,340,929	$36,144,338	$22,396,457	$45,531,573
	Georgia	$12,532,495	$2,797,705	$1,925,464	$15,673,284	$9,243,166	$26,498,830
	Kentucky	$7,868,332	$5,637,354	$1,969,116	$27,528,888	$17,504,511	$32,979,313
	LSU	$12,175,610	$2,217,358	$1,713,731	$30,935,611	$19,991,770	$36,098,469
	Mississippi	$7,264,838	$2,325,341	$1,569,722	$12,020,683	$8,032,359	$19,192,260
	Mississippi St.	$6,278,729	$1,970,204	$1,269,535	$11,012,274	$7,239,463	$16,757,931
	South Carolina	$8,798,324	$2,381,174	$1,632,144	$20,648,889	$11,827,345	$24,638,987
	Tennessee	$13,586,845	$4,503,085	$3,189,476	$39,408,713	$26,098,615	$47,378,021
	Vanderbilt	$12,296,133	$5,597,170	$3,709,080	$5,673,567	$3,961,161	$25,563,544

Differences (ACC - SEC)	FB Expenses	MBB Expenses	WBB Expenses	Not Allocated Expenses	Overhead (NA) Allocation	Major Sports Expenses
Average	($1,546,998)	$218,486	($108,461)	($5,181,121)	($3,094,825)	($4,531,799)
Min	($1,121,195)	$379,784	$122,473	$3,189,254	$1,829,627	$2,084,205
Max	$438,005	$3,406,123	$1,273,596	($16,721,057)	($11,285,704)	($5,755,451)

Appendix C: 2004-2005 Revenue

	Name	FB Revenue	MBB Revenue	WBB Revenue	Major Sports Revenue	Major Sports Expenses	Profit
Atlantic Coast Conference (ACC)	Boston College	$13,418,390	$3,367,548	$435,160	$17,221,098	$23,431,767	($6,210,669)
	Clemson	$22,334,140	$4,987,189	$420,729	$27,742,058	$26,333,193	$1,408,865
	Duke	$7,727,680	$12,394,050	$556,541	$20,678,271	$26,153,223	($5,474,952)
	Florida St.	$18,246,005	$6,832,383	$284,029	$25,362,417	$22,234,269	$3,128,148
	Georgia Tech	$10,936,408	$6,186,622	$369,085	$17,492,115	$23,021,004	($5,528,889)
	Maryland	$9,290,976	$10,357,058	$182,300	$19,830,334	$27,720,285	($7,889,951)
	Miami (Fla.)	$17,195,807	$4,695,625	$91,801	$21,983,233	$26,374,912	($4,391,679)
	North Carolina	$17,332,920	$15,016,479	$538,689	$32,888,088	$31,801,381	$1,086,707
	North Carolina St.	$14,693,373	$11,392,888	$61,669	$26,147,930	$20,389,693	$5,758,237
	Virginia	$17,304,145	$8,010,378	$5,923,235	$31,237,758	$41,622,570	($10,384,812)
	Virginia Tech	$25,263,319	$5,792,580	$899,280	$31,955,179	$27,301,609	$4,653,570
	Wake Forest	$7,226,136	$8,682,424	$15,356	$15,923,916	$18,842,136	($2,918,220)
Southeastern Conference (SEC)	Alabama	$42,979,669	$6,486,053	$149,440	$49,615,162	$31,284,560	$18,330,602
	Arkansas	$27,783,961	$11,064,656	$505,937	$39,354,554	$29,480,736	$9,873,818
	Auburn	$40,559,427	$4,090,066	$25,268	$44,674,761	$34,203,404	$10,471,357
	Florida	$43,317,641	$6,522,311	$408,604	$50,248,556	$45,531,573	$4,716,983
	Georgia	$50,895,838	$4,216,910	$68,777	$55,181,525	$26,498,830	$28,682,695
	Kentucky	$19,631,403	$12,854,928	$142,866	$32,629,197	$32,979,313	($350,116)
	LSU	$39,657,764	$4,570,748	$455,760	$44,684,272	$36,098,469	$8,585,803
	Mississippi	$15,958,445	$3,357,925	$66,248	$19,382,618	$19,192,260	$190,358
	Mississippi St.	$9,792,405	$4,755,466	$51,293	$14,599,164	$16,757,931	($2,158,767)
	South Carolina	$19,224,526	$3,880,519	$1,619,739	$24,724,784	$24,638,987	$85,797
	Tennessee	$29,326,709	$5,360,050	$4,026,702	$38,713,461	$47,378,021	($8,664,560)
	Vanderbilt	$14,453,560	$5,852,037	$962,534	$21,268,131	$25,563,544	($4,295,413)

Differences (ACC - SEC)	FB Revenue	MBB Revenue	WBB Revenue	Major Sports Revenue	Major Sports Expenses	Profit
Average	($14,384,337)	$2,058,630	$107,892	($12,217,816)	($4,531,799)	($7,686,017)
Min	($2,566,269)	$9,623	($9,912)	$1,324,752	$2,084,205	($1,720,252)
Max	($25,632,519)	$2,161,551	$1,896,533	($22,293,437)	($5,755,451)	($22,924,458)

Appendix D: 2004-2005 Winning Percentages

	Name	FB Pct.	MBB Pct.	WBB Pct.	Overall Pct.
Atlantic Coast Conference (ACC)	Boston College	0.750	0.833	0.667	0.750
	Clemson	0.545	0.500	0.286	0.444
	Duke	0.182	0.818	0.861	0.620
	Florida St.	0.750	0.387	0.750	0.629
	Georgia Tech	0.583	0.625	0.481	0.563
	Maryland	0.455	0.594	0.688	0.579
	Miami (Fla.)	0.750	0.552	0.448	0.583
	North Carolina	0.500	0.892	0.882	0.758
	North Carolina St.	0.455	0.600	0.724	0.593
	Virginia	0.667	0.483	0.656	0.602
	Virginia Tech	0.769	0.533	0.586	0.629
	Wake Forest	0.364	0.818	0.531	0.571
Southeastern Conference (SEC)	Alabama	0.500	0.750	0.483	0.578
	Arkansas	0.455	0.600	0.548	0.534
	Auburn	1.000	0.452	0.552	0.668
	Florida	0.583	0.750	0.483	0.605
	Georgia	0.833	0.286	0.706	0.608
	Kentucky	0.182	0.824	0.529	0.512
	LSU	0.750	0.667	0.917	0.778
	Mississippi	0.364	0.452	0.633	0.483
	Mississippi St.	0.273	0.676	0.586	0.512
	South Carolina	0.545	0.606	0.276	0.476
	Tennessee	0.769	0.452	0.857	0.693
	Vanderbilt	0.182	0.588	0.750	0.507