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Creating Synergistic Opportunities for Professional Adult Continuing Learners through Engineering and Technology Collaborations

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Abstract

The engineering and technology educational continuum was formalized in a 1955 report of the Committee on Evaluation of Engineering Education as part of the American Society of Engineering Education by then chair Linton Grinter. In the report there was the recognition of a dual, yet highly integrated educational continuum spanning the engineering-technology undergraduate and graduate curriculums.

Based on this report, most college and universities went on to associate under a single college or school the disciplines of engineering and technology. The curriculums were evolved with a singular focus. As time passed, theoretical instruction became more prominent and some of these colleges and schools pushed the technology portion of the curriculum to the peripheral, others simply eliminated technology altogether.

The College of Engineering's Division of Engineering Professional Education (ProEd) and the College of Technology's Center for Professional Studies in Technology and Applied Research (ProSTAR) share a common purpose, mission and vision. Underlying these is the fundamental premise that both serve the graduate educational needs of professional working adult learners in the STEM disciplines; this through credit and non-credit program offerings spanning the educational continuum of engineering and technology.

Both organizations, ProEd and ProSTAR, recognize the similarities of their mission and shared purpose to provide learning opportunities to those in technical professions with careers in progress. To this end, and aside from common policies, procedures and practices, both organizations recognize the significant commonality premised on space (facilities, equipment), distance infrastructure (distance classrooms, capture and delivery mediums), and the engineering – technology educational continuum (professional short courses, business/industry educational continuum needs). This richness in overlap creates an unquestionable synergistic opportunity for efficiency gains and cost savings.

While it is widely accepted the sharing of resources creates efficiency and subsequently lowers overall costs, the premise of this paper is solidly grounded in organizational design theory and practice. ProEd and ProSTAR, through collaboration, anticipate organizational cost avoidance and increased gross revenue through more efficient utilization of space, distance infrastructure and the engineering-technology educational continuum; therefore yielding increased net residual to the university, colleges, departments and faculty.

In the spring of 2012, under the umbrella of a new President and renewed focus on being good stewards of taxpayer dollars and student tuition, two colleges opened discussions on collaboration. The manifestation of these many earlier discussions culminated in a more focused and targeted series of meetings to determine areas for collaboration and how that collaboration might look. Primary areas for collaboration, a result of these many meetings, centers on space, distance infrastructure and the engineering-technology educational continuum.

This paper details the organizational platform for bringing two tier 1 research university colleges together for a common purpose; that being the continuing education of professional working adult learners.

Methodology

Determining the potential for gain through collaboration is minimally a function of understanding the theoretical unpinning of centralized versus decentralized organizational design models, and, the alignment of the two collaborating organizations through a better understanding of their infrastructure, target audiences, potential for increased enrollments and roadblocks to cultural acceptance.

The research questions of this study were:

- What are the theoretical advantages and disadvantages of varying centralized and decentralized organizational models?
- What alignment exists and to what extent between the organizational units under consideration for collaboration?

The methodology employed was an analysis of the two potentially collaborating organizations as well as a review of the literature on centralized and decentralized organizational models. The process began in the spring of 2012 and is currently in the latter phases of on-going analysis. The schedule below depicts the timeline of the many activities of the study.

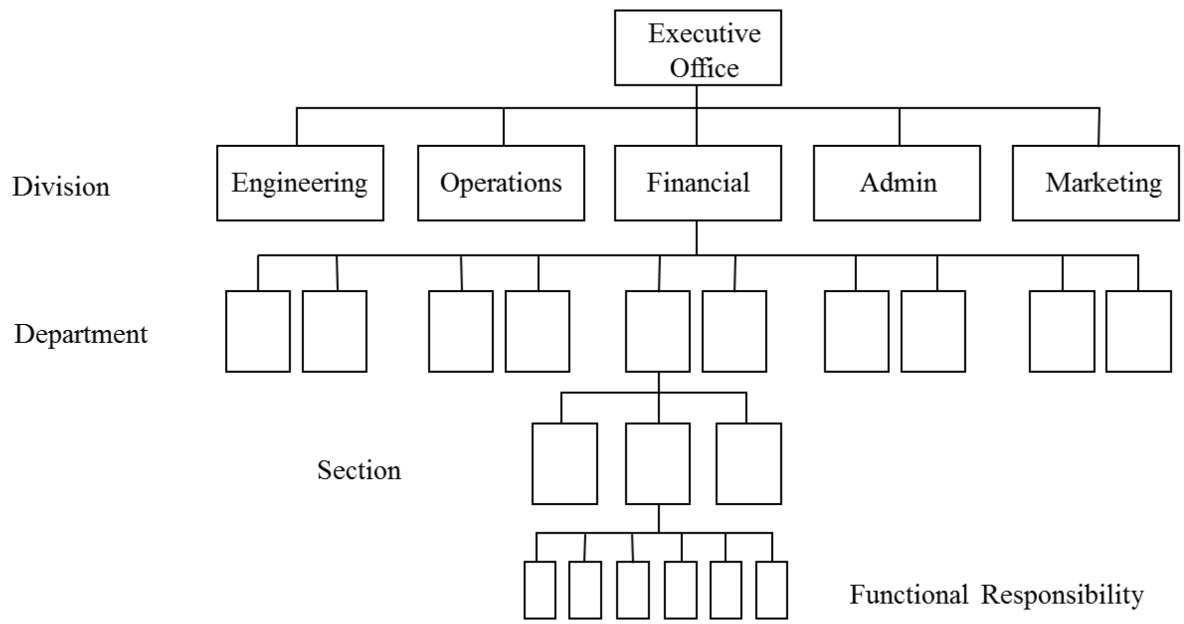
Activity	Q1 2012	Q2 2012	Q3 2012	Q4 2012	Q1 2013	Q2 2013	Q3 2013	Q4 2013	Q1 2014	Q2 2014
Research Centralized vs. Decentralized Models										
Identify Infrastructure and Overlap										
Determine Student Target Population										
Define Student Flow										
Assess Cultural Implications									On-Going	

Centralization versus Decentralization

The manner in which an organization groups work and people is referred to as an organization's structural design, or its organizational design model[1]. As an organization evolves from a small entrepreneurial entity to a mature and evolving on-going concern, so too does its organizational design model evolve. From a theoretical and experiential perspective, the evolution of these many organizational models and their attendant advantages and disadvantages is critical to a better understanding of the advantages and disadvantages of centralization versus decentralization.

Organizational design models attempt to align the three variables of accountability, authority and responsibility to gain maximum efficiency and effectiveness for the organization. A direct effect of increased efficiency is a reduction in costs, frequently referred to as cost avoidance or cost savings. Final determination of an appropriate model is premised on cost savings, versus the alternative of cost avoidance.

In the traditional organizational structure, organizational units are based on distinct common specialties, such as engineering, manufacturing, information technology and finance. The figure below depicts an example of a traditional organization structure.



Traditional Model Advantages

There are many advantages to the traditional (functional) structure. Below are listed some of the more pertinent ones:

- Easier budgeting and cost control is possible. This is true, for example, because all costs related to the above finance organization are rolled up to a single functional manager.
- Efficient use of collective experience and facilities.
- Institutional framework for planning and control. Under this type of organizational structure, planning as well as control is administered from a single functional stovepipe at the division level.
- All activities receive benefit from the most advanced technology. In this type of structure, great strength comes from focusing at the top the most state-of-the-art

methodologies, technologies, and practices, and then disseminating these throughout all organizations utilizing functional resources.

- Allocates resources in anticipation of future business. When using a functional organization structure, the functional manager has responsibility for allocating resources based on immediate needs as well as future needs.
- Effective use of production elements.
- Career continuity and growth for personnel. Under a single functional umbrella, the functional manager can assure that all personnel under that umbrella receive like education and can assure that, for example, more senior personnel are assigned projects with increasingly greater responsibility or visibility, thus aiding in career opportunities and development.
- Well suited for mass production of items.
- Communication channels are vertical and well established.

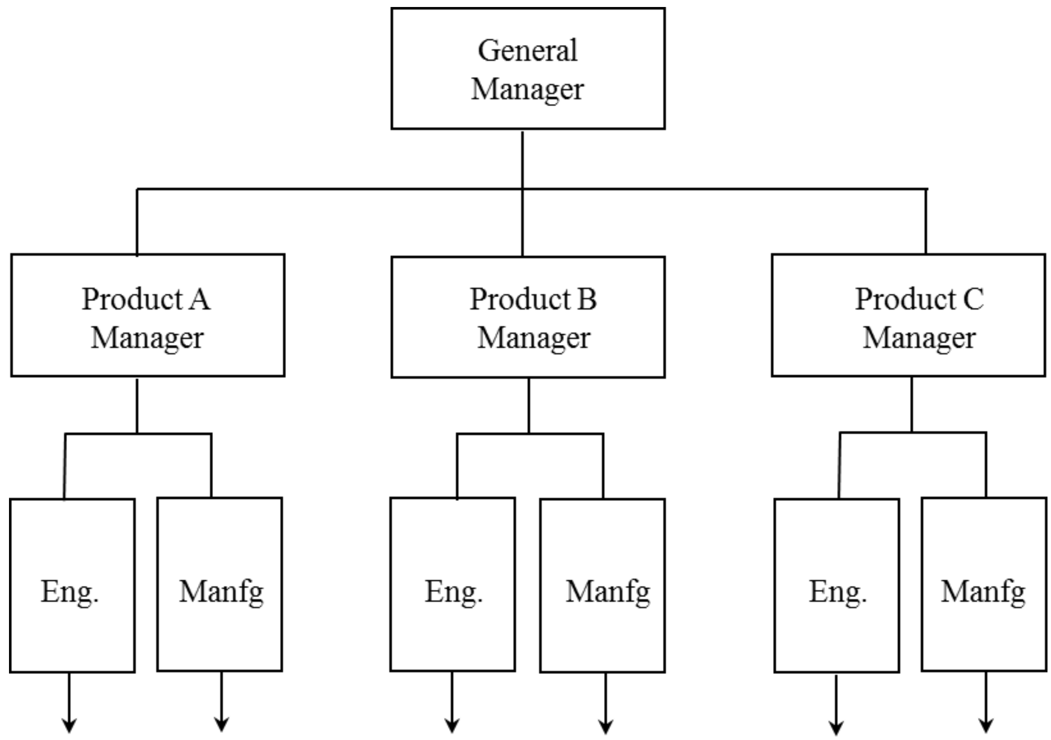
Traditional Model Disadvantages

The traditional (functional) organization has many disadvantages as well. The more predominant disadvantages are:

- There is no central project or product authority. With this type of organizational structure, the many functions simply come together, usually centered on the type of program, and contribute to the accomplishment of the program's goals.
- Little or no project planning or reporting. Without a single program manager to be held accountable for the program's overall tasks, the functional managers simply concern themselves with their functional responsibility, therefore causing potential programmatic concerns.
- Poor horizontal communication across disciplines/functions. Employees whose care and feeding comes from a functional stovepipe will generally take great care to nurture those individuals in that stovepipe who have supervisory control. Naturally, a stronger bond with functional management will occur over interfaces with horizontal functions.
- Difficult to integrate multidisciplinary tasks.
- Tendency of decisions to favor strongest functional group. This is true especially if the functional group is taking the lead on a given program.
- Response to customer needs is slow, primarily because functions are more concerned with functional activities than program activities.
- Ideas tend to be functionally oriented.
- Projects have a tendency to fall behind schedule. This stems from a lack of a single program manager tending to programmatic concerns.

Product Design Model

In a product organizational structure, distinct operating units are organized around, and given responsibility for, a major product or product line. The figure below depicts a typical product-oriented structure. For purposes of this discussion, products could be loosely associated with academic units.



Product organizational structures are centered on major product or brand lines. For example, if an organization produced dish soaps, toothpaste, facial tissue, and so on, each might become a product structure and have its own product manager. Worth noting in the above is that other functions are replicated within each product organization. This is discussed further below.

Product Model Advantages

- Strong control by a single product authority.
- Rapid reaction time. The product manager has all of the resources he or she needs to be successful, and can command these resources in any way required to satisfy the customer's changing needs.
- Encourages performance, schedule, and cost tradeoffs.
- Personnel are loyal to a single individual. Where that individual was the functional manager in the traditional structure, it is the product manager in this type of structure.
- Interfaces well with outside units. Here a single product manager is given primary responsibility for interfacing with other units, both externally and internally.

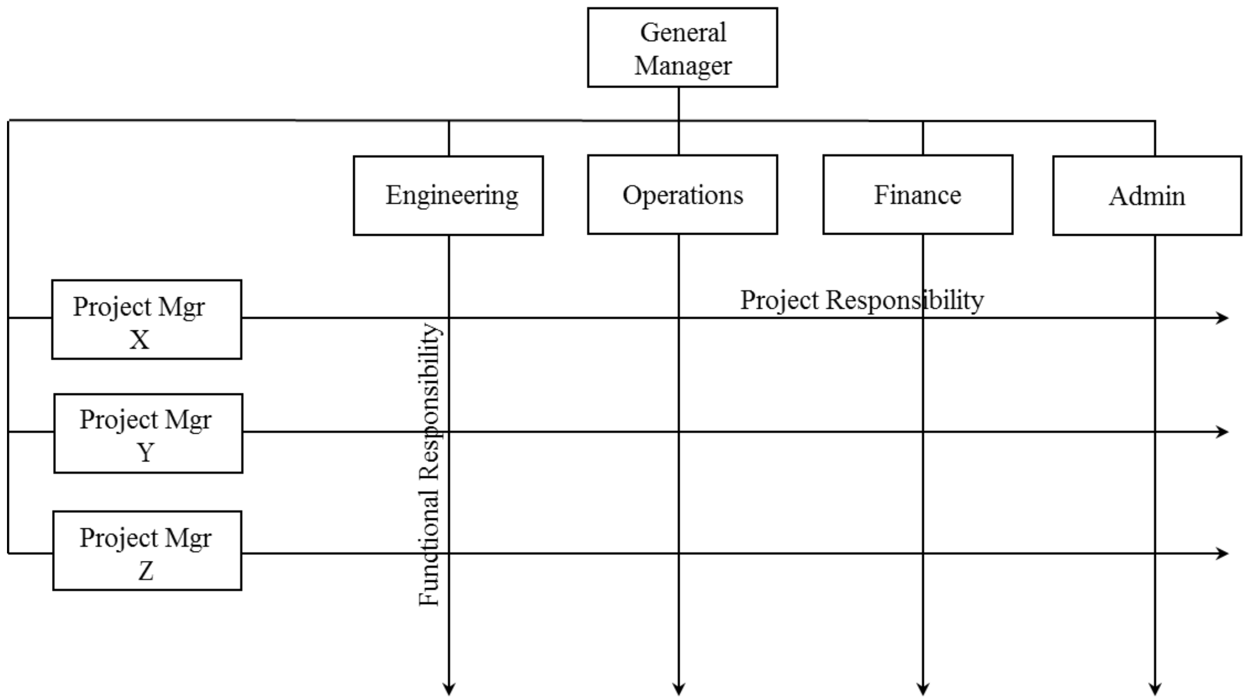
- Strong communication channels. It helps in this type of structure that all employees have a common goal: to produce a single product or brand of product. This builds a unified allegiance to a single cause.

Product Model Disadvantages

- Inefficient use of resources; duplication of effort. This may be the single greatest argument against this type of organizational structure. The fact that, in the above example, engineering, finance, and so on are duplicated for every product line implies full-time employees are being used where part-time employees may only be required.
- Does not develop strong functional technology. Single individuals performing a single function on the product do not have the time or the breadth of exposure to see what the latest and greatest methodologies, techniques, and practices may be.
- Does not prepare for future business. Without functional oversight, the entire product organization is focused on design, development, and delivery of a single product or brand. If greater vision does exist, it typically is limited to similar, or like, products.
- Less opportunity for technical interchange among projects.
- Minimal career opportunity and continuity for project personnel. In other words, there may be limited growth potential.
- Difficulty in balancing workloads as projects phase in and out. Individuals may not have work in a particular time frame, but must be kept busy doing something until that specific type of function is again in demand.

Matrix Design Model

The matrix structure is a hybrid organization that attempts to balance the use of human resources as people are shifted from one project to another. It can be viewed as a project organization superimposed over a functional organization. The figure below is an example of a typical matrix organizational structure.



The matrix structure is more complex than either the traditional or product-oriented structures. To this end, it requires some basic ground rules to be successful:

- Participants must spend committed time on a project; this ensures a degree of loyalty.
- Horizontal as well as vertical channels must exist for making decisions.
- There must be quick and effective methods for conflict resolutions.
- There must be good communication channels between managers.
- All managers must have input into the planning process.
- Both horizontal and vertical managers must be willing to negotiate for resources.
- Horizontal line must be willing to operate as a separate entity except for administrative purposes.

In a matrix organizational structure:

- There should, ideally, be no disruption due to dual accountability.
- A difference in functional management judgment should not delay work in progress.

Matrix Model Advantages

Advantages of the matrix organizational structure are predominantly focused on efficiency and cost savings, this through a centralized focus on the knowledge, skills and abilities of people and the efficient allocation of those people across academic units:

- Promotes career continuity and professional growth, as each discipline-specific individual has a home discipline outside of the academic unit; meaning, the individual can be retrained and redeployed in other discipline-specific required capacities.
- Perpetuates consistent and coherent technology. By this, functional discipline resources gain the benefit of a functional strength of knowledge and skills, which can be transferred to the academic unit.
- Resources may be retrained and redeployed without an academic unit having to take personnel actions. For example, the information technology (IT) function, as the home department of all IT personnel, assumes any and all personnel actions.
- Resources may be used in multiple shared capacities. This supports the level and full loading of each individual, versus partial loading expanded to fill a full-time load requirement.

Matrix Model Disadvantages

Disadvantages of the matrix organizational structure include:

- Dual accountability of personnel. This is perhaps the biggest threat to this type of structure. Personnel will generally favor whoever it is that completes their performance review and subsequently has control over their income adjustments. Confusion here can derail a collaborative effort.
- There are continuously changing priorities, especially on the part of the academic units who control the resources.
- Employees may feel confused about loyalty.

Centralization, through a matrix organizational design model, therefore, provides the greatest opportunity for increased efficiency and subsequent cost savings.

Cost Avoidance versus Cost Savings

Cost avoidance is not the same as cost savings. Cost avoidance that does not directly lead to a cost savings may in fact actually lead to a cost increase.

An example best illustrates this difference. If a process is made more efficient, such that it used to take three people two hours each, or six person hours in total, and now takes one person one hour, that is a cost avoidance, through a process improvement, of five person hours. So, it may be stated that the organization, through process improvement, has saved five person hours. If those saved five person hours are simply reapplied to other areas of work, then there are no real savings, simply a cost avoidance through the improvement of one process.

Real savings, in contrast, are savings that have a direct reduction to the bottom line performance of the organization or unit. To be short, if the five person hours saved in our above example resulted in not paying someone for the five person hours, then that saved cost is realized in the bottom line of the financial statement. In other words, an organization or unit could give back to the oversight entity the equivalent of five person-hours worth of funding.

Cost savings, then, are real and have a direct impact on the bottom line of the financial statement. Whereas, cost avoidance may result in an improvement contributing to increased efficiency or effectiveness, but does not necessarily result in real cost savings; i.e., a realized reduction in expenses against an activity base, which may be returned to a parent organizational entity.

Cost savings may be realized through one, another or combination of activities. Namely:

- A unified approach to common hardware and software platforms.
- Reduction in required new hires – this is a reduction through attrition, reallocation and consolidation of lower-skilled positions into fewer, more highly-skilled positions.
- Recognition and personnel actions relative to a skills mix issue – a model frequently used in business and industry and premised on Jack Welch's General Electric model put forth in his 2000 report to shareholders, which advocates the churning of the bottom 10% of personnel on an annual basis.

Functions Performed Across Potentially Collaborating Units

In reviewing the administrative units of the potential collaboration, it was determined the following best represents those primary functions performed by each.

- Marketing
- Recruiting
- Orientation
- Program delivery
- Registration
- Bursar (other outside unit)
- Continuing education through the university continuing education and conferences organization
- Graduate school (other outside unit)
- Financial aid (other outside unit)

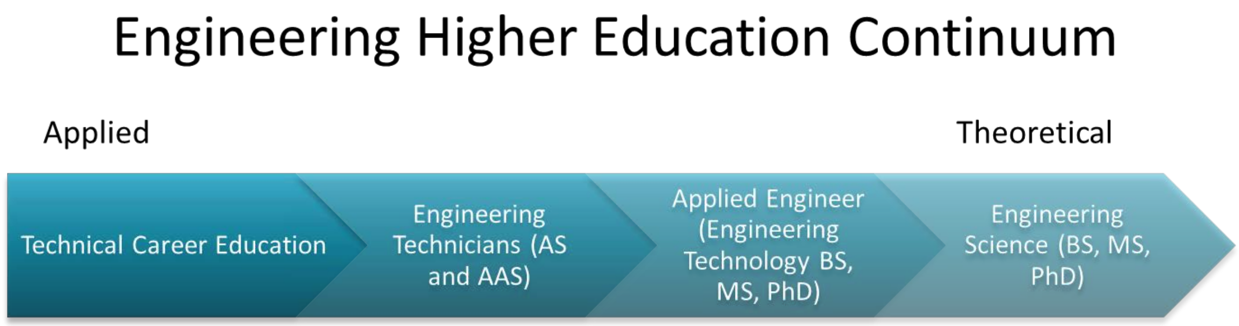
While both of the target collaborating organizations perform the above functions and interface with those entities identified as other outside units, the two organizations do not perform these functions in the same manner. In the final analysis, it was determined there was an overlap in functions performed and "other outside units". This overlap, while intuitive on the surface, was deemed to provide opportunity and subsequent impetus for further collaborative study.

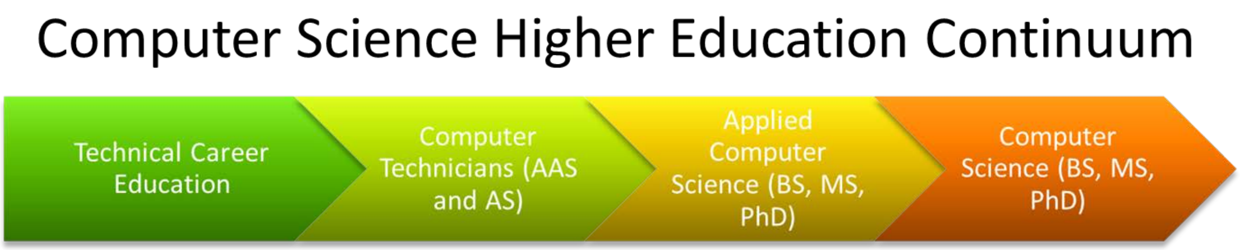
Who are the Students?

The following four charts help to define and better understand the professional working adult learners who are potential participants to fee-based programs;

- the engineering-technology continuing educational continuum,
- the engineering and technologists titles and roles as mapped to the basic product life cycle,
- the mapping of programs between the two collaborating administrative units, and,
- the path students might take to enter one or both of the programs represented by the administrative units.

The following depicts the engineering-technology educational continuum.





In looking at the above, left to right indicates increasingly greater levels of knowledge. Clearly delineated is the transition of knowledge and skills from theoretical knowledge (far right) to applied knowledge (2nd from right). This reinforces the engineering-technology educational continuum. Below depicts the alignment of programs between the two colleges.

Applied Engineering	Theoretical/Applied Engineering
College of Technology Programs	**College of Engineering Programs**
Aeronautical Engineering Technology	Aeronautics and Astronautics
Aviation Management	Aeronautics and Astronautics
Professional Flight	Aeronautics and Astronautics
Building Construction Management	Civil Engineering/Construction Engineering and Management
Computer Graphics Technology	College of Science/Computer Science
Computer Information Technology	College of Science/Computer Science
Electrical Engineering Technology	Electrical and Computer Engineer
Engineering Technology	Electrical and Computer Engineer
Engineering-Technology Teacher Education	Engineering Education
Industrial Distribution	Industrial Engineering
Industrial Technology	Industrial Engineering
Manufacturing Engineering Technology	Industrial Engineering
Mechanical Engineering Technology	Mechanical Engineering
Organizational Leadership and Supervision	Engineering Leadership @ Purdue (ELP)

The above maps the College of Engineering's "parent" theoretical program to the child College of Technology's derived applied program. In two instances, the College of Science's Computer Science program would be the "parent" theoretical program.

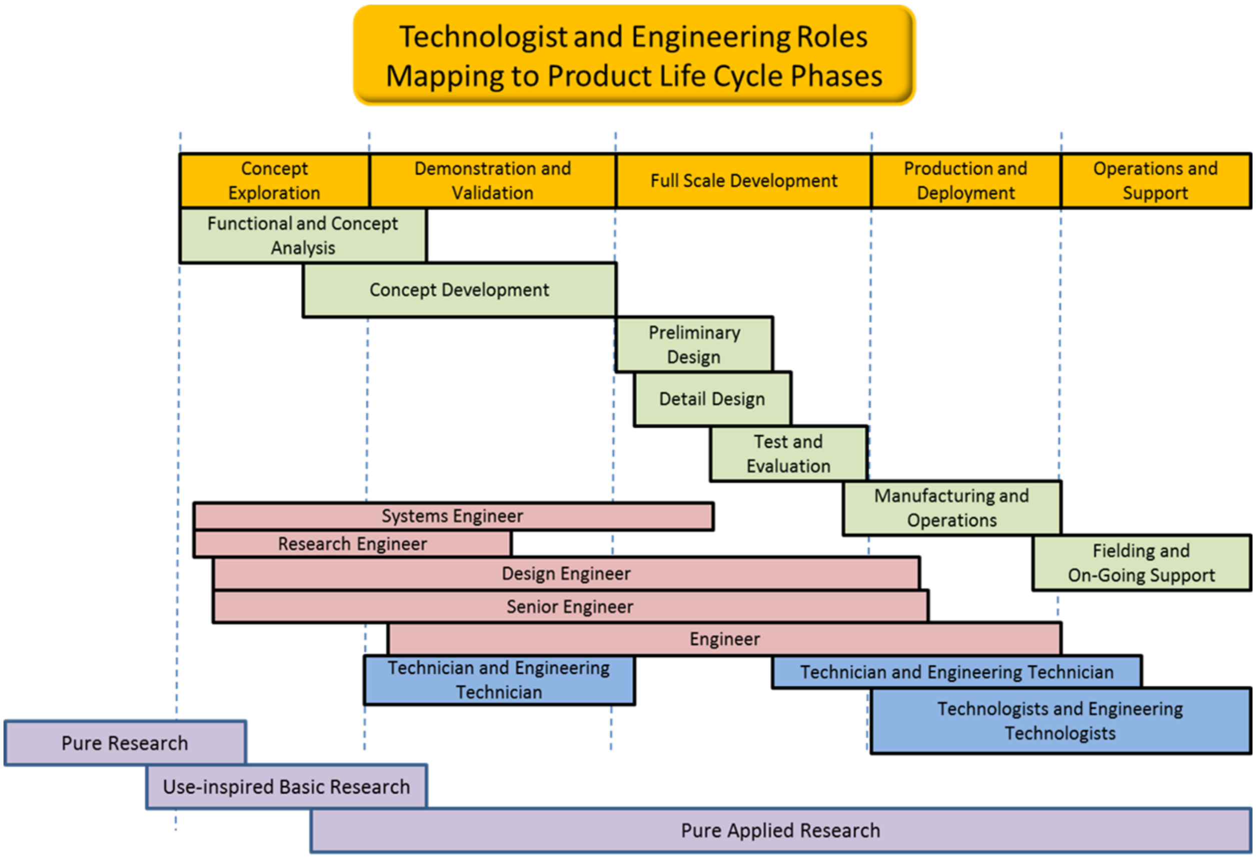
Understanding the curriculum continuum in business and industry is critical to providing a targeted and applicable course delivery to adult professional learners pursuing a graduate degree through continuing professional studies administrative organizations[2,3,4].

The following depicts the titles assigned to graduate technology and engineering majors mapped to the generally accepted product life-cycle model phases[5,6,7,8].

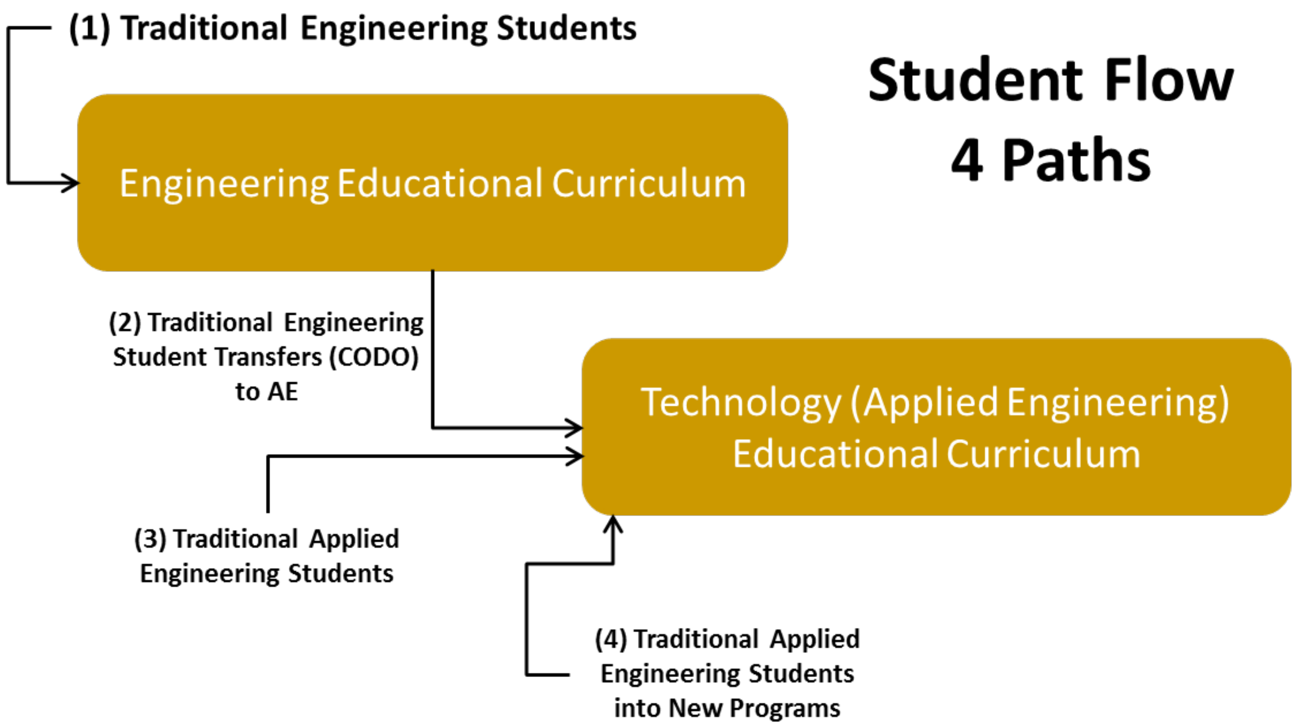
In any new successful endeavor, whether it is product/process design or making a business contact to determine educational needs of adult professional learners, the first step is to determine basic needs or requirements of the target audience; in this scenario, the focus is adult professional leaners and their respective businesses and industries.

At the macro view, there are five major phases to a product's life cycle; concept exploration, demonstration and validation, full scale development, production and deployment, and, operations and support.

Worth noting, the above is representative of a perspective, it is not singularly defined and used unanimously by all business and industry organizations involved in the product design, development and implementation through product life cycle processes. The below model does however, provide a natural and required additional deeper perspective on the differentiation and understanding of the roles predominantly occupied by technologists and engineers. It also allows for a greater understanding of the engineering to applied engineering natural continuum for product design, development and implementation.



The below depicts the flow of students into each of the administering organizations. Because the entry requirements are more stringent for the engineering programs, the reverse flow of students is not expected. The recognized educational continuum however, is expected to provide greater engineering enrollment because of transitional opportunities.



Analysis

From the above, the research questions of this study were:

- What are the theoretical advantages and disadvantages of varying centralized and decentralized organizational models?
- What alignment exists and to what extent between the organizational units under consideration for collaboration?

Centralization, collaboration in this scenario, based on theoretical and experiential understanding does provide a more efficient and cost effective organizational design model.

The two organizations of this collaboration do have overlap in functions performed. This overlap may be later developed through a shared vision of continuing collaboration.

Expected Outcomes

The expected outcomes of this collaboration are a(n):

- Consistent and coherent face to STEM fee-based graduate education
- Increase in efficiency
- Reduced overall cost (cost savings not cost avoidance)
- Increased student enrollment

- Providing opportunity that might not normally otherwise be available
- Increased gross revenue
- Increased net residual

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