ASEE 2022 ANNUAL CONFERENCE
Excellence Through Diversity
MINNEAPOLIS, MINNESOTA, JUNE 26TH-29TH, 2022 ASEE
Paper ID #36434

Historical Natural Evolution of Thought of a First of its Kind Online Doctor of Technology Degree Program in a Tier-1 University

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Abstract

The university of this paper proposed the creation of a Doctor of Technology (D. Tech.) graduate degree program to be delivered as a hybrid model from the main university campus to active/employed technology professionals. This degree program was distinctly different than the existing Ph.D. in the college of this program in multiple ways including the delivery mode, the target clientele, the focus of learning activities, and the research aims of the program.

In addition to purposing the degree towards the development of technology and R&D competence needed by business, industry and government, the vision was to employ a hybrid delivery system involving predominantly distance learning education plus some campus-based experiences that make the achievement of a doctoral degree far more accessible to practicing professionals who would not pursue a doctorate or Ph.D. in a traditional campus setting due to their work and home responsibilities. The program, in its final implementation was entirely online.

Over the last two years there have been numerous conversations on the academic, institutional, financial, faculty and academic department compensation models, and other decisional aspects of a Tier-1 university Doctor of Technology (D. Tech.) degree program.

These many conversations with peers and aspirationals, were oriented around how this program came to be, what considerations were critical to its success, how the many institutional financial models work with this new program, and other similarly attendant questions.

The originators of this program have found themselves repeating these similarly reenacted conversations, providing this university's specific answers to similarly situated peer/aspirational program questions.

The purpose of this paper is to identify, define, articulate, and otherwise expand upon those natural evolutionary thoughts and implementation details asked by others within higher education, and specifically, those institutions of higher education who are considering university specific instantiations of their own.

This paper will discuss and explore decisions made in, but not limited to, the areas of:

- Program characteristics – which includes the proposed mode of delivery and the format of the program.
- Rationale for the program.

- ❑ Researched evidence of a labor-specific market need – specifically identifying the national, regional, and state needs.
- ❑ Identified business and industry needs.
- ❑ Identified research doctorates and their applicability to this doctorate.
- ❑ Identified related needs from the U.S. Department of Labor – which includes national, regional, and state studies.
- ❑ The determination of potential demand from past existing online master's students. This data insight will include:
    - In state versus out of state initial interest.
    - National versus international past student interest.
    - Past academic degree conferrals.
    - Student interest by age, gender, race, and ethnicity.
- ❑ Program competencies and learning outcomes.

This paper will promote national conversation on the possibilities of varying institutions providing an online doctorate program to those students who would not otherwise have access to this type of program.

What is a Doctor of Technology Degree?

A doctorate is an academic degree of the highest level. There are three types of doctorates: research, professional, and honorary. The most common type of research doctorate is a Ph.D. (Philosophy Doctor or Doctor of Philosophy). Professional doctoral degrees (also called first professional degrees) are awarded in certain fields where most holders of the degree are in a profession, such as law, medicine, music, or ministry, and are not engaged primarily in scholarly research and academic activities [1].

The as implemented Doctor of Technology (D. Tech.) degree program is a research-based doctorate, with predominate applicability to use-inspired basic research and/or purely applied research and development, versus the traditional pure-basic research of the Ph.D. [2].

Table 1 below contains just a few of the many identified research doctorates:

Research Doctorates	
Doctor of Arts (D.A.)	Doctor of Musical Education (D.M.E.)
Doctor of Architecture (D.Arch.)	Doctor of Ministry (D.Min./D.M.)
Doctor of Applied Science (D.A.S.)	Doctor of Modern Languages (D.M.L.)
Doctor of Business Administration (D.B.A.)	Doctor of Music Ministry (D.M.M.)
Doctor of Canon Law (J.C.D.)	Doctor of Medical Science (D.M.Sc.)
Doctor of Chemistry (D.Chem.)	Doctor of Nursing Science (D.N.Sc.)
Doctor of Criminal Justice (D.C.J.)	Doctor of Public Administration (D.P.H.)
Doctor of Comparative/Civil Law (D.C.L.)	Doctor of Physical Education (D.P.E.)
Doctor of Criminology (D.Crim.)	Doctor of Public Health (D.P.H.)
Doctor of Education (Ed.D.)	Doctor of Professional Studies (D.P.S.)
Doctor of Environmental Design (D.E.D.)	Doctor of Design (Dr.DES.)
Doctor of Engineering (D.Eng.)	Doctor of Religious Education (D.R.E.)
Doctor of Environment (D.Env.)	Doctor of Recreation (D.Rec./D.R.)
Doctor of Engineering Science (D.E.Sc./Sc.D.E.)	Doctor of Rehabilitation (Rh.D.)
Doctor of Forestry (D.F.)	Doctor of Sacred Theology (S.T.D.)
Doctor of Fine Arts (D.F.A.)	Doctor of Science (D.Sc./Sc.D.)
Doctor of Geological Science (D.G.S.)	Doctor of Science in Dentistry (D.Sc.D.)
Doctor of Hebrew Literature/Letters (D.H.L.)	Doctor of Science and Hygiene (D.Sc.H.)
Doctor of Health and Safety (D.H.S.)	Doctor of Science in Veterinary Medicine (D.Sc.V.M.)
Doctor of Hebrew Studies (D.H.S.)	Doctor of Sacred Music (D.S.M.)
Doctor of Industrial Technology (D.I.T.)	Doctor of Social Science (D.S.Sc.)
Doctor of Juridical Science (S.J.D.)	Doctor of Social Work (D.S.W.)
Doctor of Juristic Science (J.S.D.)	Doctor of Technology (D. Tech.)
Doctor of Library Science (D.L.S.)	Doctor of the Science of Law (L.Sc.D.)
Doctor of Music (D.M.)	Doctor of Theology (Th.D.)
Doctor of Musical Arts (D.M.A.)	

Table 1. Generally Identifiable Research Doctorates

Professional Doctorates are typically categorized as depicted below in table 2:

Professional Doctorates	
D.C. (Doctor of Chiropractic)	D.P.M. (Doctor of Podiatric Medicine)
D.D.S. (Doctor of Dental Surgery)	D.M.D. (Doctor of Dental Medicine)
J.D. (Juris Doctor or Doctor of Law)	D.V.M. (Doctor of Veterinary Medicine)
M.D. (Medicine Doctor or Doctor of Medicine) (US)	Psy.D. (Doctor of Psychology)
D.P.T. (Doctor of Physical Therapy)	Pharm.D. (Doctor of Pharmacy)
D.O. (Doctor of Osteopathic Medicine)	O.D. (Optometry Doctor or Doctor of Optometry)

Table 2. Generally Identifiable Professional Doctorates

How Did the Doctor of Technology Evolve?

The Doctor of Technology (D. Tech.) degree evolved over a six- and one-half year period prior to being approved in the fall of 2019.

In 2011, a thought-leading team of graduate-oriented faculty from discipline-specific departments was assembled to research and conceptualize what such a degree might look like and how it might be best delivered. The team launched three parallel research efforts [3], [4], [5]:

- To ascertain what precedents and experiences with similar goals existed around the world, i.e., an international review of other doctoral programs addressing similar needs.
- To begin the process of identifying the curriculum and course content of the program.
- To conduct an interest and needs assessment of a sample of high probability individuals.

The findings of all studies were positive, and their key features incorporated into subsequent decision making [6], [7].

Then, in the fall of 2019, the D. Tech. degree program was approved, after having been passed through the internal university approvals and the State's Commission of Higher Education [8].

How Was the Business Need Envisioned?

For-profit business and industry exist to benefit the shareholders [6]. They do so through the offering of products and services which meet the ever-changing demands of their respective customers. To meet the needs of customers, business and industry requires a strong technological focus, one premised on constant innovation and improvement. To this end, business and industry firmly resides in the use-inspired and pure-applied spectrum of the engineering-technology educational curriculum continuum.

From a 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.

Each of these life-cycle phases is punctuated with use-inspired and pure-applied application of technological understanding and advancement [2]. Failure to be a "technology" company most readily results in declining market share and reduced value and return to shareholders, which, runs counter the basic premise of maintaining and growing an on-going economic concern. Business and industry are in the "technology" business.

A Technology Doctorate would focus on the use-inspired and pure-applied engineering-technology educational curriculum continuum which maps directly to the premise for sustainability and growth of a given business/industry [8], [9].

How Was the Student Need Envisioned?

Professional adult learner students of a Doctorate in Technology would pursue a terminal degree targeting use-inspired and pure-applied knowledge for one or both of two reasons: (1) to better serve the needs of their respective organizations and ultimately their end users/customers, and/or (2) to advance their careers either within their current organizations or another as opportunities exists.

Additionally, there is a growing recognition, as documented in the literature, that higher levels of education are required to gain fruitful employment that once required a lesser educational skill set. According to the Bureau of Labor Statistics, roughly 36% of the U.S. population of 315M individuals have BS/BA degrees, this higher than any previous period in U.S. history. Master's degree holders make up roughly 13% of this same population with holders of Doctoral degrees residing at 3%.

Given the significant growth in the supply of intellectual capital, both nationally and internationally, in these last two decades, gaining access to employment opportunities that used to require a high school degree now require a BS/BA degree. The MS degree is used as the primary source of differentiation between business/industry employed individuals. Those possessing the knowledge and skills of a doctoral level education may expect to not only further differentiate themselves in terms of educational cognition, but by their ability to provide greater technology innovation management and leadership.

In essence, the more education one acquires, the greater the likelihood for continued gainful employment and the greater the financial rewards. As is the case with any entrepreneurially oriented individual, the acquisition of a doctoral level education is highly sought after. Current wait lists reflect this backed-up demand.

What Thoughts Were Given to Job Role Differentiation and Rewards?

In business/industry titles and roles map to product life cycle phases. As a project evolves from Concept Exploration to Operations and Support, different skill sets are required. In the early phases of the product life cycle, research and systems thinking/engineering are dominant. As the product life cycle moves to the right toward full scale development, systems operation and engineering gives way to product design, development, and systems integration. This left to right transition in the product life cycle requires a transitioning from a higher level of systems understanding to a tactical level of team and individual discipline-specific knowledge; software engineering, hardware engineering, operations and the specialty engineering disciplines.

Given this natural transitioning of required knowledge and understanding, those individuals with discipline-specific knowledge would expect to, and would generally, be promoted into positions requiring higher levels of cognitive functioning upon conferment of a Doctorate in Technology and demonstrated skills.

The promotion in role responsibility with attendant title, naturally create greater financial rewards for the individual as the individual's demonstrated contributions to the company increase.

How Was the Demand Determined?

To better understand the demand for the proposed Doctor of Technology degree, the D. Tech. leadership team administered a Qualtrics survey of past and current students (1999-2017) of professional fee-based credit programs who have either graduated or were planned to graduate in the spring of 2017. The survey asked each recipient to rate their interest in a new Doctor of Technology (D. Tech.) degree, on a Likert scale of 0 to 5, where 0 = no interest and 5 = very interested.

Of the 978 surveys sent, there were 334 respondents (34%). Of the 334 respondents, 219 (66%) were either "very interested" or "interested" in the newly proposed Doctor of Technology program. Of the 334 respondents, 80 (24%) said they "might have an interest" in the newly proposed program. Figure 1 below depicts the number of respondents per Likert selection.

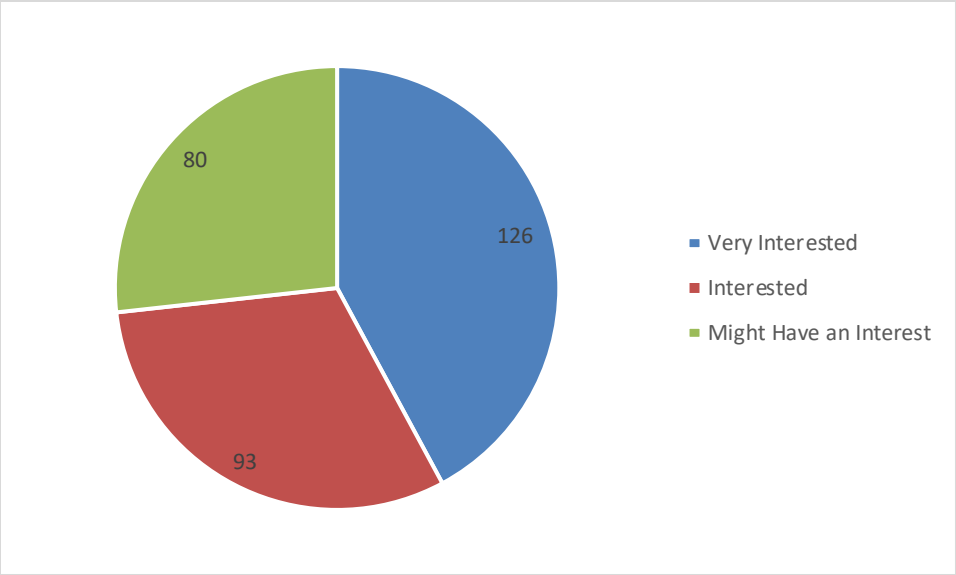

Figure 1. Number of Respondents by Interest Level

Of the 219 respondents who were either very interested or interested in the newly proposed Doctor of Technology program, 109 (50%) said there were likely to receive some form of company financial support.

Of the 219 students who were either very interested or interested in the newly proposed Doctor of Technology program, 191 respondents were U.S. citizens. Of the 191 respondents who were U.S. citizens, 103 (53.9%) were from inside the state of Indiana, while 88 respondents (46.1%) were from outside the state of Indiana. Figure 2 depicts the in- versus out-of-state residents.

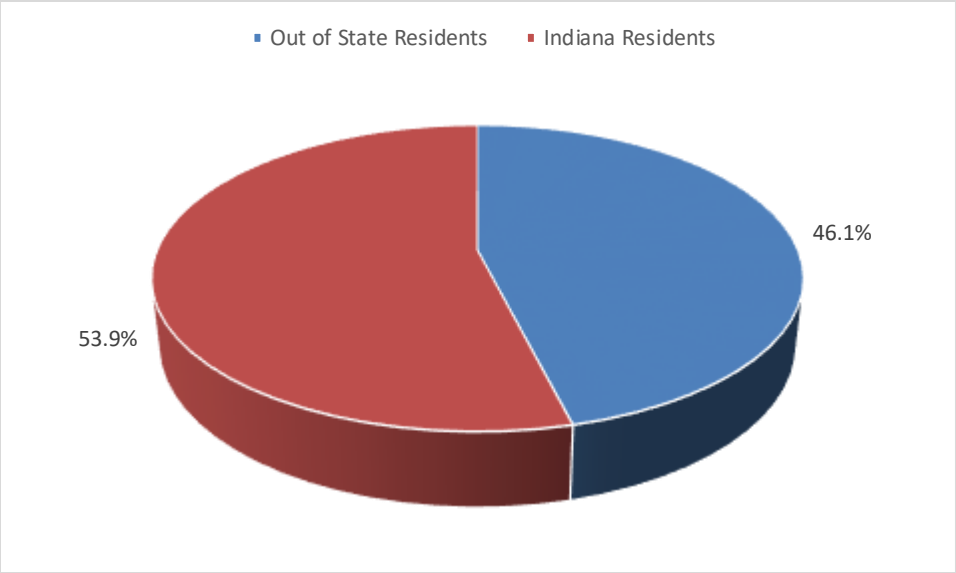

Figure 2 In-State Versus Out-of-State Who Have an Interest in the Program

Of the 219 respondents, 191 (87%) were from within the U.S., while 28 respondents (13%) were outside of the U.S. Of the 28 respondents from outside of the U.S., the largest populations were from Nigeria (3.7%), Kenya (2.7%) and Uganda (2.3%). Figure 3 reflects the number of respondents by country.

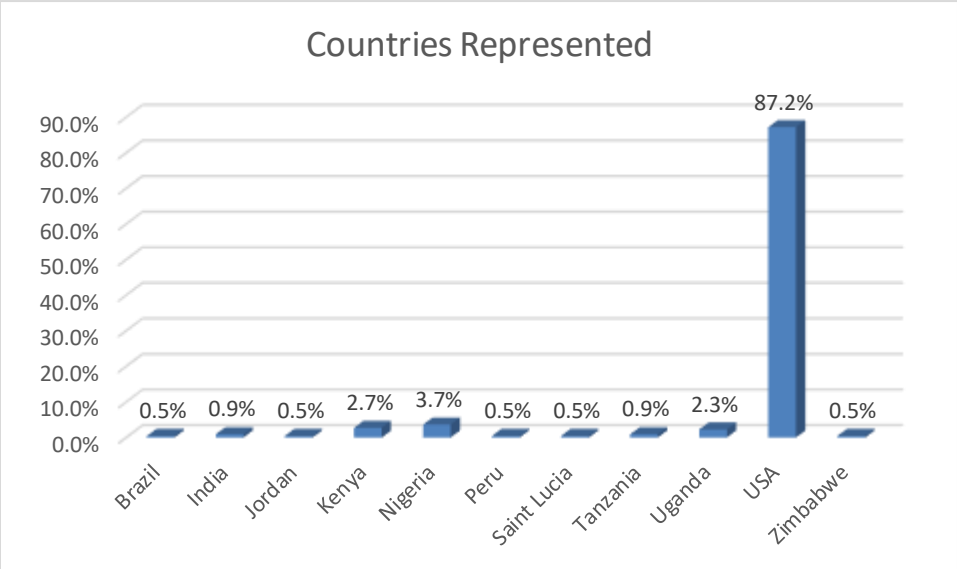

Figure 3. Number of Respondents by Country of Origin

Of the 219 respondents, there were 159 unique companies represented. With the top industries being pharmaceuticals, defense, and heavy machinery respectively.

Relative to which cohorts the 219 students represented: of the 219 respondents:

- 67 (31%) were from a previous weekend distance-hybrid program (with 55% from the Leadership weekend program)
- 66 (30%) were from the Biotechnology and Regulatory Science cohorts
- 37 (17%) were from information technology and related cohorts
- 21 (9.6%) were from aviation and related cohorts

Figure 4 depicts the number of respondents by previous administered programs.

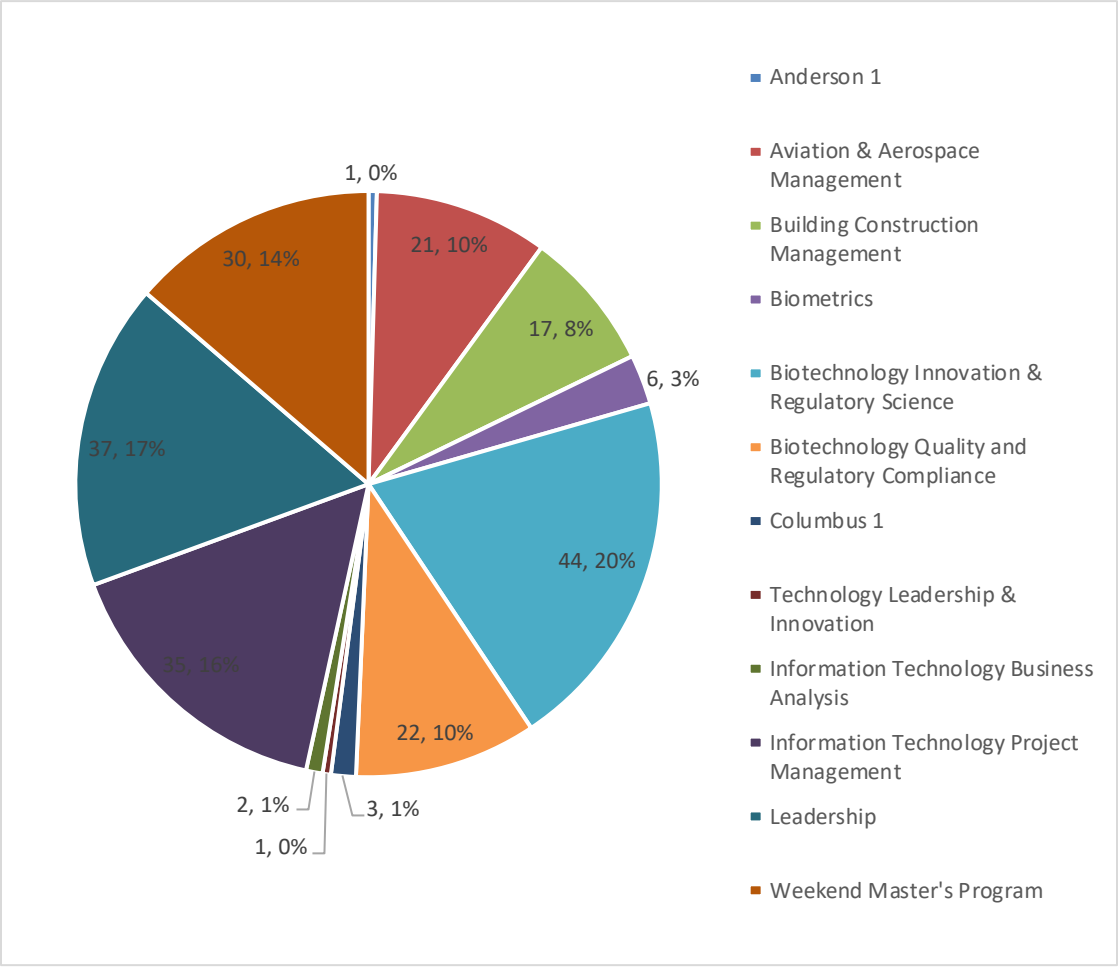

Figure 4. Number of Respondents by Previously Administered Programs

Of the 219 respondents, the average age is 41 years of age. The largest single age range was 31-35 years of age (22%), followed by 36-40, 41-45 and 46-50, each at 16% respectively. The chronological age of the respondents is directly related to the number of years of work experience, and subsequently as a professional working adult learner [11].

Age	# of Respondents	Percentage of Respondents
22-25	5	2%
26-30	24	11%
31-35	48	22%
36-40	36	16%
41-45	34	16%
46-50	34	16%
51-55	19	9%
56-60	13	6%
61-65	6	3%

Table 3. Percentage of Respondents by Age Cohort

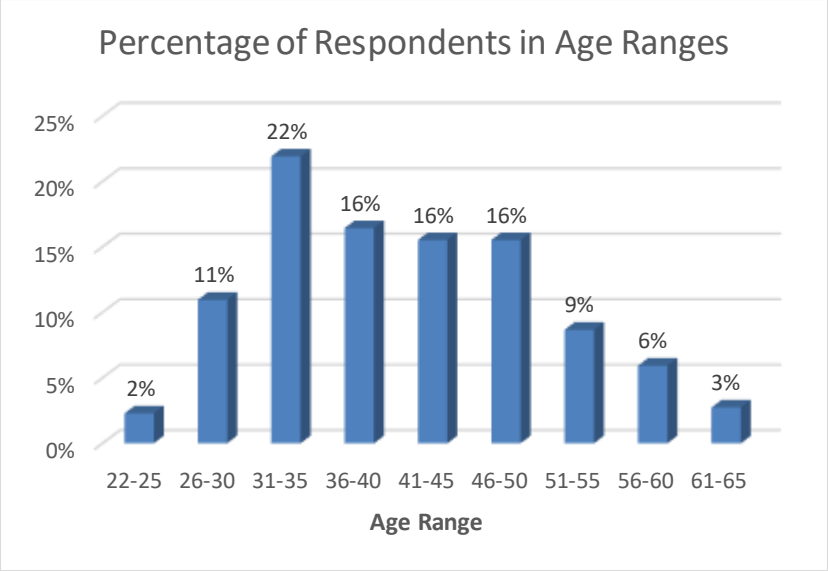

Figure 5. Graphical Depiction of Respondents by Age Cohort

Of the 219 respondents, 145 (66%) were male, while 74 (34%) were female.

Gender	# of Respondents	Percentage of Respondents
Male	145	66%
Female	74	34%

Table 4. Respondents by Gender

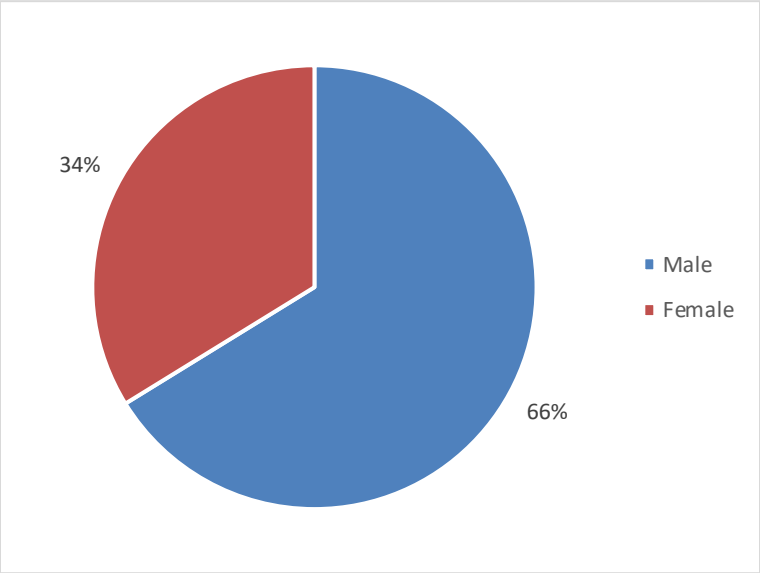

Figure 6. Percent of Respondents by Gender

While ethnicity reporting is voluntary and highly variable, of the 219 respondents reporting, 105 (48%) self-reported as being underrepresented minorities. Of the 105 respondents who self-reported, the largest ethnicities were black or African American (58%), Asian (23%) and Hispanic (19%).

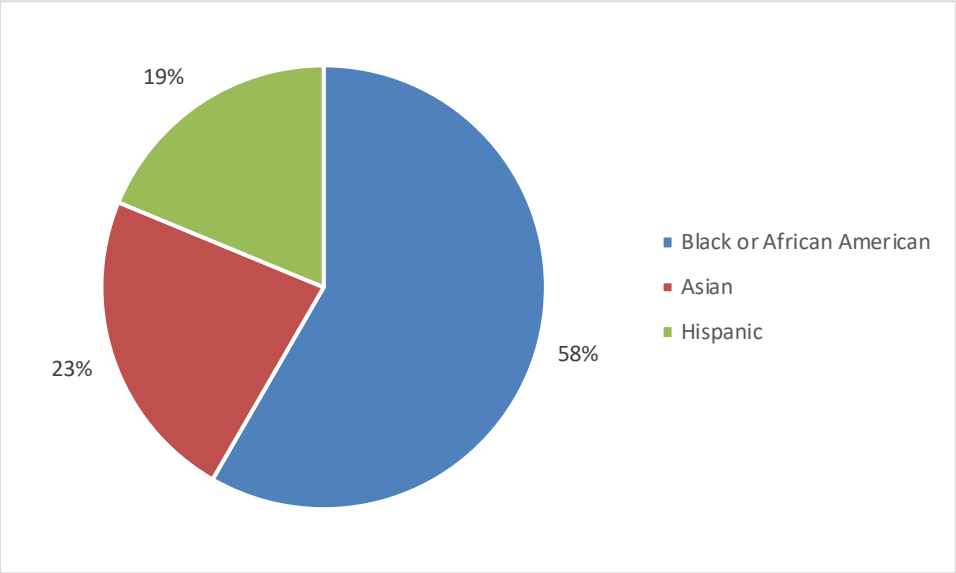

Figure 7. Percent Respondents Self-Reporting as Underrepresented Minorities by Ethnicity

What was the forecasted potential Demand at the State and National Level?

The Indiana Department of Workforce Development (DWD) data do not specifically address demand for Doctor of Technology graduates, but overall demand for advanced degrees was expected to increase by 14.5% over the current decade, and the projected increase in jobs for STEM occupations needing advanced degrees is projected to increase by 27.1%. The DWD predicts strong statewide growth during the same time frame for multiple STEM-related occupations that this degree program would potentially serve at varying levels including [12]:

- Construction Managers, 7,839 positions, 7.8% increase projected
- Medical and Health Services Managers, 9,890 positions, 19.9% increase projected
- Management analysis, 11,802 positions, 20% increase projected
- Computer Systems Analysts, 9,814 positions, 25.2% increase projected
- Software Developers, Systems Software, 3,864 positions, 17.9% increase projected
- General and Operations Managers, 4,187 positions, 10.9% increase projected
- Database Administrators, 1,929 positions, 13.1% increase projected
- Computer and Information Systems Managers, 1,550 positions, 18.7% increase projected
- Training and Development Specialists, 5,490 positions, 10.9% increase projected
- Education Administrators, Elementary & Secondary, 4,330 positions, 6.6% increase projected
- Network and Computer Systems Administrators, 7,743 positions, 10.8% increase projected
- Chief Executives, 4,438 positions, 1.5% increase projected

The US Bureau of Labor Statistics' *Occupational Outlook* Handbook [13] included the middle level business and industrial operational personnel among their list of 20 occupations with the highest projected number of new jobs projected for 2014-2024. Based on the proportion of R&D employment in America's workforce it was estimated that between 5-11% of the 151,000 reported new jobs would involve R&D and of these a significant proportion would require higher levels of education such as master's and doctoral degrees.

The U.S. Bureau of Labor Statistics projected increases in many of the tracks for this program for doctoral or professional degrees as shown below. Additionally, the US Department of Labor reported that .8% of all civilian employment requires a doctoral degree.

- Construction Managers, 373,200 positions, 5% increase projected
- Architectural and Engineering Managers, 182,100 positions, 2% increase projected
- Management Analysts, 758,000 positions, 14% increase projected
- Computer and Information Systems Managers, 348,500 positions, 15% increase projected
- Computer and Information Research Scientists, 25,000 positions, 11% increase projected

- Software Developers, 1,114,000 positions, 17% increase projected
- Network and Computer Systems Administrators, 382,600 positions, 8% increase projected
- Industrial Designers, 38,400 positions, 2% increase projected
- Operations Research Analysts, 91,300 positions, 30% increase projected
- Top Executives, 2,467,500 positions, 6% increase projected
- Human Resource Managers, 122,500 positions, 9% increase projected

Does the D. Tech. Require a Master's Degree for Admittance?

Direct admit from a Bachelor's degree into the Doctor of Technology (D. Tech.) degree was not initially envisioned or allowed. However, subsequently, there has been added the possibility of an individual direct admitting into the D. Tech. program if his/her BS/BA degree credentials, letters of reference, and job advancement indicates the individual would prove successful once admitted.

Those wishing to enter into the D. Tech. program with a Master's degree will need an accredited Master's degree as approved by the D. Tech. University's Graduate School. If a student has a Master's degree from the D. Tech university, then pursuit of a similar track within the D. Tech. degree will likely result in transfer in of the maximum (30) hours allowed.

If the student has a Master's degree from an accredited college/university, as approved by the University's Graduate School, but not obtained through the university of the D. Tech., then the number of hours allowed to be transferred into the D. Tech. degree will be variable as determined and subsequently approved by the academic department of the D. Tech approved plan of study the student wishes to pursue.

In either scenario, the maximum allowable hours to be transferred into the D. Tech. program will be 30.

Transfer of students from other degree programs, or other universities will follow the University's standard transfer admission process. Course equivalencies will be determined through the normal processes, and the number of graduate courses allowed will be determined following the guidelines of D. Tech. University's Graduate School.

What are the Degree and Other Requirements?

The Doctor of Technology will require at least 90 credit hours of course work and research. Students who enter the Doctor of Technology program with an earned master's degree from an accredited/recognized university can apply a maximum of 30 credit hours toward the 90 credit hours required for the degree.

Program requirements include:

- Selecting a Research Advisor/Major Professor
- Establishing a graduate program/advisory committee.
- Securing approval of and successfully completing the Plan of Study.
- Passing a Preliminary Exam including Written and an Oral.
- Submitting a dissertation proposal.
- Submitting and defending a dissertation.

Doctor of Technology students will be guided by a 4-member graduate committee consisting of at least three regular members of University's Graduate faculty, with one of the three graduate faculty members representing the student's cognate discipline. Additionally, one member should come from business/industry or other relevant practice arena as relevant to the student's purpose statement. The business/industry mentor will have earned at least a master's degree and will occupy a position of responsibility that represents an aspiration of the doctoral student. This proposal incorporates a request that Graduate School will afford such a member an appropriate classification to permit their participation on both the student's graduate and examining committees.

The purpose of the proposed Doctorate in Technology is to develop advanced level practitioner-researchers able to work at the forefront of technology, and as such will require a traditional doctoral dissertation. Much of such work occurs at the emerging interface of two or more technology disciplines and this necessarily involves research and development.

To succeed in such demanding arenas advanced practitioner-researchers need to be able to understand, evaluate, conceptualize, and conduct research and in particular applied, use-inspired research. While this might be teachable at an abstract level, the faculty are convinced that by actually conceptualizing, proposing, and conducting such research advanced practitioners develop higher level skills, understandings and appreciation for the complexities, trade-offs and nuances involved in research and the dissertation is the preferred method for accomplishing this.

Requiring a recognizable dissertation, in-line with other university Ph.D. programs, ensures comparable levels of rigidity, integrity, and quality of a research-based doctorate program offered through this university.

What Are the Program Competencies or Learning Outcomes?

Upon completion of the D. Tech, students should be able to:

- Envision, plan, and conduct applied research and development activities.
- Identify, comprehend, analyze, evaluate, and synthesize research and professional practice.

- ❑ Evaluate technologies and technology-related programs.
- ❑ Assess individual performance with, and understanding of, technology.
- ❑ Communicate effectively and employ constructive professional and interpersonal skills.
- ❑ Function at a high level in one or more of the technology disciplines.
- ❑ Employ quantitative, qualitative, analytic, and statistical techniques to technological problems.
- ❑ Apply advanced leadership practices to organizational challenges.
- ❑ Conduct sophisticated systems analysis and design activities.

Below are examples of sub-outcomes for learning outcomes listed above.

- ❑ Envision, plan, and conduct applied research and development activities.
  - An applied dissertation
  - A proposal for an applied R&/or D project
- ❑ Identify, comprehend, analyze, evaluate, and synthesize research and professional practice.
  - Advanced literature search & retrieval from government, corporate, and international sources
  - Employ data analytics
- ❑ Evaluate technologies and technology-related programs.
  - Perform a technology assessment employing critical criteria
  - Describe the pros and cons and intended and unintended consequences of technology policy
- ❑ Assess individual performance with, and an understanding of, technology.
  - Engage in systematic technological futuring
  - Develop and implement a personal professional development plan focusing on technological capability
- ❑ Communicate effectively and employ constructive professional and interpersonal skills.
  - Document the conceptualization and conduct of an industrial/business technology-related research R and/or D project with an in-depth cogent research report
  - Prepare compelling presentations tailored for specific audiences
- ❑ Function at a high level in one or more of the technology disciplines.
  - Apply systems theory to root cause analysis of a technological challenge/problem
  - Demonstrate the ability to resolve technological problems into their energy, material, and information components
- ❑ Employ quantitative, qualitative, analytic, and statistical techniques to technological problems
  - Perform multivariate analyses and test the significance of the finding
  - Demonstrate effective content analysis of textual or verbal data
- ❑ Apply advanced leadership practices to organizational challenges
  - Employ conflict resolution techniques to increase the effectiveness of an organizational unit/team
  - Evolve a plan to capitalize on the diversity of a work group
- ❑ Conduct sophisticated systems analysis and design activities
  - Develop an analysis matrix of information, material, & energy flows in a technological system
  - Design a solution to a technological challenge by addressing root causes

What Was the Originally Projected Headcount, Full-Time Equivalent (FTE) Enrollment, and Degrees Conferred?

In addition to purposing the Doctor of Technology degree towards the development of technology and R&D competence needed by professionals in business, industry and government, the vision was to employ an online delivery modality absent campus-based experiences.

The proposed Doctor of Technology degree is a professional doctorate, i.e., a terminal degree, focusing on in-depth understanding of and capability with technology and the concomitantly necessary, innovation, and leadership skills of middle and senior leaders in industry, business, and government as well as NGOs.

It was expected that the program would initially enroll up to 20 professional working adult learners in year one; 20 additional working professional adult learners would be admitted in year two and 20 additional working professional adult learners in year 3. Annual enrollments were expected to hold steady at 20 new students each subsequent year. Given the three-year expected time to program completion and graduation, this yielded an average total student enrollment of 55-60 students at any one point in time (assuming normal attrition/deferment rates based on past experience).

As previously stated, the D. Tech. program enrolled nearly 250 active students within the first two semesters of its offering.

Conclusion –

The Doctor of Technology degree has proven to be successful well beyond initial projections and anyone's expectations. There may be numerous reasons for its success, including:

1. Name recognition of the program's university.
2. Increases in number of U.S. individuals attaining BS/BA degrees.
3. Increases in number of U.S. individuals attaining a MS/MA degree.
4. Recognition degree credentials further differentiate those with advanced degrees from those who do not in a highly competitive job market.
5. Desire to advance within an individual's existing company.
6. Desire to increase job prospects outside of an individual's current employer.
7. Sheer interest in continuing to gain increasingly higher levels of advanced education.

The purpose of this paper was to identify, define, articulate, and otherwise expand upon those natural evolutionary thoughts and implementation details asked by others within higher education, and specifically, those institutions of higher education who are considering university specific instantiations of their own. It is believed this paper satisfies this purpose.

It is as well intended this paper promote national conversation on the possibilities of varying institutions providing an online doctorate program to those students who would not otherwise have access to this type of program.

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