

A BHEF CASE STUDY

DATA ANALYTICS AND DECISION SCIENCES AS A DESTINATION AREA

Virginia Polytechnic Institute and State University develops innovative new program to create VT-shaped students

ABOUT BHEF

The Business-Higher Education Forum (BHEF) is the nation's oldest membership organization of Fortune 500 CEOs, college and university presidents, and other leaders dedicated to the creation of a highly skilled future workforce. BHEF members collaborate and form strategic partnerships to build new undergraduate pathways; improve alignment between higher education and the workforce; and produce a diverse, highly skilled talent pool to meet demand in emerging fields.

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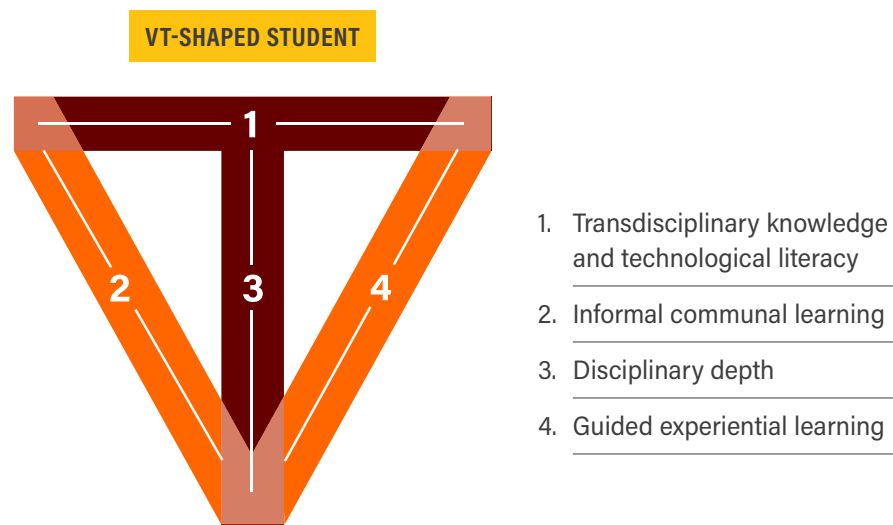
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TABLE OF CONTENTS

01	Introduction
02	Program Overview
04	The Challenge
06	The Solution
11	Insights

INTRODUCTION

THROUGH THE COLLABORATION of its business and higher education members, the Business-Higher Education Forum (BHEF) launched the National Higher Education and Workforce Initiative (HEWI) to create new undergraduate pathways in high-skill, high-demand fields such as data science and analytics. Because of the massive amount of digital data created daily, knowledge of data science and analytics has become a fundamental skill for graduates' career readiness in recent years. To be applied effectively, data science and analytics education must be integrated with T-shaped skills, such as critical thinking, collaboration, and effective communication, which are critical for all graduates entering the 21st-century workforce. This case study examines how BHEF member Virginia Polytechnic Institute and State University (Virginia Tech) is integrating T-shaped skills into its VT-shaped student model for the Destination Areas, particularly data analytics and decision sciences.



SOURCE
undergraduate.provost.vt.edu/vt-shaped-student.html

PROGRAM OVERVIEW

TO PREPARE STUDENTS FOR THE 21ST-CENTURY workplace and a global, interconnected world, Virginia Tech is combining its world-leading research, faculty, and technology with a strong experiential component to create five Destination Areas. Each Destination Area is a cross-cutting, interdisciplinary approach to undergraduate education majors designed to facilitate the development of VT-shaped students. The Data Analytics and Decision Sciences Destination Area addresses the ubiquitous nature of data science today and prepares students to lead in a world where evidence-based decisions and systems are pervasive. Through the creation of the Destination Areas, Virginia Tech is successfully engaging its business partners, supporting faculty research, and preparing students to become the next generation of leaders and doers.

FIVE INITIAL SUB-THEMES IN THE DATA ANALYTICS AND DECISION SCIENCES DESTINATION AREA

Healthcare analytics

Infrastructure analytics

Financial resilience analytics

Security analytics

Social analytics





THE NEXT GENERATION OF DEERS & DOERS

DATA ANALYTICS AND DECISION SCIENCES AS A DESTINATION AREA

A young woman with long dark hair, wearing a blue hoodie, is sitting at a desk in a classroom. She is looking intently at a laptop screen. The laptop screen displays a human anatomy diagram with a red circle highlighting a specific area. In the background, other students are visible, some looking at books or papers. The overall scene is dimly lit, with a warm, golden-brown color palette. The text 'THE CHALLENGE' is overlaid in a large, serif font, with 'THE' in smaller letters above 'CHALLENGE'. A thin horizontal line is positioned below the title.

THE CHALLENGE

*Weaving data science into the learning
and research experience of students*

THE WORKFORCE OF THE FUTURE is expected to become less stable and more global, interconnected, mobile, specialized, and technology-mediated. The students of the future will increasingly seek not only jobs but also purpose and meaning in their employment. Higher education should adopt an adaptable, reflexive, and sustainable approach that reflects the world in which students will live and work.

In the era of big data and digitization, data science and analytics spans all fields of work and study and impacts everyone's daily lives, personally and professionally. Given the ever-present nature of data today, Virginia Tech embraced the challenge of weaving data science into the learning and research experience of students in every discipline.





THE
SOLUTION

*Create a purpose-driven VT-shaped student
who is adaptable, resilient, and culturally competent*

VT-SHAPED STUDENTS

In the T-shaped student model, the vertical leg of the “T” represents the student’s disciplinary depth of knowledge. The horizontal arm of the “T” represents the student’s breadth of knowledge and skills as well as his or her interdisciplinary capacities, including the development of crosscutting skills such as critical thinking, collaboration, effective communication, global perspective, and project management. Virginia Tech moves beyond the model of the T-shaped student to create the VT-shaped student. Virginia Tech’s addition of the “V” represents purpose-driven engagement and is meant to reinforce the “T” through guided experiential and communal learning. The VT-shaped student is adaptable, resilient, and culturally competent, motivated to address real-world problems and opportunities through a sense of empathy and the university’s motto, *Ut Prosim* (That I May Serve).

To create the VT-shaped student, Virginia Tech itself must become VT-shaped. In this model, the vertical leg of the “T” represents the university’s individual disciplines and the horizontal arm represents the Destination Areas that connect them. To incorporate the “V,” Virginia Tech has both a formal learning opportunity, which may involve an industry partner or research in one of the university’s leading research institutes in the capstone course, and an informal learning opportunity, which will transform its campus spaces into living-learning communities around Destination Area themes. Students will live, work, and learn with researchers, teachers, and mentors as well as collaborate with partners outside the university in global living laboratories, where ideas are developed and tested in real-world settings.

THE SOLUTION

DESTINATION AREAS

Destination Areas were created as part of Virginia Tech's Beyond Boundaries initiative, a one-year, long-range university visioning process led by President Timothy Sands. Completed in the 2015-2016 academic year, Destination Areas do not refer to where the university is going; rather, they are the crosscutting themes that attract people, projects, and partners to Virginia Tech.

Destination Areas offer students crosscutting, interdisciplinary majors with a strong experiential component designed to facilitate the development of VT-shaped students. Destination Areas focus on real-world problems, offering students engagement in purpose-driven, "hand-on, minds-on" work.

Students and faculty across disciplines, along with key external partners, collaborate to confront these problems and form solutions at points of intersection, preparing graduates who are ready to flourish in the new economies.

In fall 2015, Virginia Tech began the process of identifying the Destination Areas in partnership with university deans, directors, faculty, and external business partners. Once the Destination Areas were established, Virginia Tech tapped the expertise of faculty in a series of town hall meetings to further refine their descriptions. Faculty design teams, in concert with representatives from across the university, are leading the development of the curriculum and guiding programmatic development for each Destination Area.

PATHWAYS TO GENERAL EDUCATION

Scheduled for launch in 2018, Pathways to General Education (Pathways) is Virginia Tech's new general education curriculum. Developed through a multi-year process by faculty teams, Pathways provides three options to fulfill general education requirements. The first is a traditional distributive pathway model in which students choose courses from different categories that are mandated by credit hour requirements. The second is an interdisciplinary minor designed to complement a student's chosen discipline. The third is an alternative pathway that provides students with more flexibility for meeting general education outcomes, which can include study abroad, co-curricular experiences, and undergraduate research.

In concert with these new pathways, Virginia Tech has been reimagining the role of data science in its general education curriculum. For example, the university has changed its Quantitative and Symbolic Reasoning requirement to a Quantitative and Computational Thinking requirement. As part of this new requirement, an introductory course in data science is now being created. Virginia Tech has also piloted a Computational Thinking course that is designed for non-science, technology, engineering, or mathematics (STEM) students. These new courses will serve as a strong foundation for students who choose to pursue the Data Analytics and Decision Sciences Destination Area.

Faculty were supported throughout the process of creating the new general education curriculum. All of Virginia Tech's curricular support units, including the Center for Instructional Development and Educational Research, the Office of Assessment and Evaluation, the Technology-enhanced Learning and Online Strategies unit, the Office of Undergraduate Academic Affairs, the Office of General Education, and the academic advising community collaborated with the faculty on areas such as authentic assessment, learning outcomes, and the capstone experience. For the Pathways minor in particular, faculty were encouraged to connect with like-minded colleagues across campus through the university's institutes and workshops.

As part of the co-curriculum, Virginia Tech will create living-learning communities tailored to each Destination Area theme. Residence halls will be structured to allow students and faculty to live, work, and learn together. External partners will be invited to engage in the research and interact with students and faculty as well. These communities foster student learning by making learning a part of, rather than separate from, the living experience.

Virginia Tech is developing a framework that lowers the barriers for crosscutting learning opportunities with business. Unlike the typical one-to-one relationship between a company representative and a faculty member or a corporation and a specific department or college, the university is establishing a new corporate engagement center aimed at attracting professionals with business development backgrounds to serve as relationship managers between a particular company and the university as a whole. Opportunities for company engagement will be centrally managed through a single portal at both the graduate and undergraduate levels. Virginia Tech will also create a standard template to provide companies with the opportunity to sponsor a project and avoid the typically lengthy contract negotiations associated with such efforts. With the help of colleagues from across campus, including student life, advanced research, and contracting, the resulting framework will simplify and improve the corporate engagement process throughout the university.

The university has made a number of commitments to the Destination Areas in its new budget model. In September 2016, Virginia Tech announced plans to build a \$225 million Global Business and Analytics Complex to provide a common facility for faculty, students, and partners that are passionate about an analytic approach to real-world problems. Virginia Tech also plans to invest \$75 million over five years to build additional teaching and research capacity in another Destination Area, Intelligent Infrastructure for Human-Centered Communities. In addition, Virginia Tech plans to financially support cluster hires and provide faculty incentives to teach interdisciplinary courses for the Destination Areas.

DATA ANALYTICS AND DECISION SCIENCES DESTINATION AREA

The Data Analytics and Decision Sciences Destination Area teaches students to visualize, explain, and predict the response of massively interacting systems to address pressing challenges in health, habitat, and well-being. Data analytics and decision sciences is about improving the human condition, in which every person needs food, shelter, clean water, health care, security, and education. Data, especially the translation of data from basic science to the evidence-based policy domain, is the key to a better life.

This Destination Area capitalizes on Virginia Tech's leadership in research in all layers of the "data stack," including data mining/analytics algorithms, new high-performance data-intensive computing platforms, and visualization capabilities. It also builds on Virginia Tech's current efforts to train students in data-driven disciplines at all levels through innovative new undergraduate majors (e.g., computational modeling and data analytics, environmental informatics), graduate degrees (e.g., master of science in business analytics), and graduate certificates (e.g., data analytics).

COMPUTATIONAL MODELING AND DATA ANALYTICS INFORMATION

The Data Analytics and Decision Sciences Destination Area at Virginia Tech addresses the presence of data science everywhere today. In the era of big data, Virginia Tech believes that every professional must become conversant in data science to be successful and that data collection and analysis are crucial guides for sense-making, discovery, and decision-making. By weaving data science into the learning and research experience of students in every discipline, Virginia Tech's graduates will be prepared to lead in a world where evidence-based decisions and systems are pervasive.

COMPUTATIONAL MODELING AND DATA ANALYTICS

The bachelor of science in computational modeling and data analytics (CMDA) is a degree designed for entry into the world of big data and computational mathematics. By combining elements of traditional disciplines, such as statistics, mathematics, and computer science, with new interdisciplinary courses, Virginia Tech has created a quantitative sciences program that trains students in emerging computational techniques for a wide variety of application areas, including defense, energy, finance, health care, and social media. The program focuses on extracting information from large data sets as well as analyzing and solving problems by modeling, simulation, and optimization.

The CMDA degree has been and continues to be informed by the needs of the workplace. Students are trained in problem-solving, communication, teamwork, and the ability to not only use but also grow with the changing spectrum of massive data techniques. Graduates gain the skills to process and model enormous quantities of data in ways that provide maximal insight in any realm that depends on information.

The CMDA degree program also benefits from companies such as Agilix Technologies, Inc., Gaito LLC, and General Dynamics, who sponsor projects or provide ongoing feedback to the curriculum.

The CMDA degree, housed in the College of Science's Academy of Integrated Science, consists of 120 credits that students earn following one of two options: the general option or the integrative quantitative science (IQS) option. The two options accommodate the different types of students pursuing the CMDA degree. The IQS option, which takes students immediately into the integrated world of CMDA, is intended for students selecting the major early in their college career. The general option is intended for students entering the major later who have already embarked on a traditional major such as statistics or

computer science. This includes transfer and other students who have acquired an appropriate amount of relevant, entry-level credits.

The CMDA curriculum provides students with the opportunity to dive deeply into a specific area through choice of electives, a disciplinary track, or a minor or double major. Students take courses in mathematical modeling, computational methods, data management, and data analytics. Through a capstone course, every student is involved in a guided research project, requiring application of the integrated computer, mathematics, and statistics skills he or she has developed throughout the program. This capstone course allows

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CMDA majors to tackle a meaningful data/modeling problem presented from a client either at the university or in industry. In addition to honing technical skills, the course emphasizes student leadership and team dynamics. Peer evaluations shed light on student performance, presentations provide students with an opportunity to practice their communication skills, and students apply ethics in a concrete way by examining how their models might have unintended consequences. Altogether, the capstone course is structured to provide students with an intentional and targeted learning experience to equip them with the skills that industry needs.

The CMDA curriculum was developed and is delivered by three primary depart-

ments at Virginia Tech with strengths in quantitative science: mathematics, statistics, and computer science. This diffuse structure allows faculty to more easily combine elements of these disciplines to develop innovative courses that incorporate the techniques in applied computation most necessary for tackling today's complex data-based problems. To aid in the delivery of courses, the program has received administrative support for targeted hiring of new faculty who complement the research strengths of existing faculty. Although considered to be full-fledged members of their departments, these faculty also teach in the integrated program and are valued for

their contributions to both their department and the program.

Virginia Tech has strongly supported the development of interdisciplinary programs such as CMDA. In particular, the College of Science created the Academy of Integrated Science to administer these types of interdisciplinary programs. These programs benefit from a significant amount of autonomy and curricular flexibility because they are purposely structured to bridge multiple departments and are not

anchored in a single department.

Launched in the 2016-2017 academic year, the CMDA program has 265 students with about 25 students in its graduating class. This number far surpasses the program's original goal of 110 students by 2018-2019. Moving forward, the CMDA program will address the challenges presented by a larger-than-anticipated program that has attracted a wide variety of students with varying degrees of mathematical preparation across disciplines. The CMDA degree is also being used to inform the data science courses for the new Pathways program and serves as a model for the development and implementation of the Data Analytics and Decision Sciences Destination Area.

INSIGHTS

A CLEAR VISION AND LEADERSHIP COMMITMENTS FROM SENIOR ADMINISTRATION SUPPORT INTERDISCIPLINARY INITIATIVES

The Destination Areas resulted from a vision set by President Sands in the Beyond Boundaries initiative and is led by Executive Vice President and Provost Rikakis. The administration made a series of commitments to the Destination Areas in its new budget model, including financially supporting cluster hires, providing faculty incentives to teach interdisciplinary courses, and creating customized facilities. In addition to enabling the work of the Destination Areas, these efforts encourage rather than discourage engagement in the university's interdisciplinary efforts. Through these investments and commitments, the administration is providing a solid foundation for the success of interdisciplinary initiatives such as the Destination Areas.

A VT-SHAPED STUDENT MODEL EXPANDS UPON T-SHAPED SKILLS

In addition to the disciplinary knowledge and interdisciplinary capacities represented in the T-shaped student model, Virginia Tech has added a "V" to represent purpose-driven engagement through guided experiential and communal learning. To incorporate the "V," Virginia Tech offers both a formal and informal learning opportunity. Students engage in the formal learning opportunity through a capstone course, in which they may partner with industry or engage in research at one of the university's research institutes, and in the informal learning opportunity through the living-learning communities created around Destination Area themes. By transforming its approach to learning across disciplines and its campus spaces, Virginia Tech is creating an environment that will reinforce the development of T-shaped skills and produce the VT-shaped student.

STRONG FACULTY LEADERSHIP FACILITATES THE DEVELOPMENT OF INTERDISCIPLINARY EFFORTS

Virginia Tech was able to build on and learn from the efforts of faculty leaders involved in the Pathways and CMDA programs. To support these previous efforts, faculty had already been connecting and collaborating with colleagues across campus as well as integrating the efforts of offices throughout the university to implement the new program. Faculty also had developed expertise on working with partners throughout the university and in business to implement capstone projects for undergraduates as well as working across colleges to develop and deliver the curriculum. The insights and lessons learned from these programs provided a strong foundation for and facilitated the development of the larger, interdisciplinary Destination Area effort.

LOWERING BARRIERS TO ENGAGEMENT PROMOTES STRONG RELATIONSHIPS WITH THE BUSINESS COMMUNITY

Virginia Tech is lowering the barriers for business engagement through the creation of a new corporate engagement center. The new center facilitates relationships between companies and the university as a whole rather than a single faculty member or department by using relationship managers who have a deep understanding of individual companies and how they can work with Virginia Tech. The university will also streamline opportunities for company engagement by using a single portal for their management and by developing a standard template for project sponsorship. This new framework for engagement will simplify and strengthen the university's relationship with the business community.

“Ultimately, we want to be a destination for talent—faculty, staff, students, and collaborators. With support and input from BHEF and external partners, we’re moving rapidly into the spaces that will attract talent, augment our strengths, and expand opportunities for global leadership. Data analytics, decision sciences, and other continually evolving areas of focus will also support the development of our version of the T-shaped student. **The ‘VT-shaped’ student will be prepared to work across disciplines, embrace technology, evaluate data, take bold steps, and adapt to change—**critical skills for career resilience over a lifetime.”

TIMOTHY D. SANDS / PRESIDENT / VIRGINIA TECH

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